# HT-IDE3000 User's Guide

February 2014

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Part I

# Integrated Development Environment

Chapter 1

# Overview and Installation

1

To ease the process of application development, the importance and availability of supporting tools for microcontrollers cannot be underestimated. To support its range of MCUs, the company is fully committed to the development and release of easy to use and fully functional tools for its full range of devices. The overall development environment is known as the IDE, while the operating software is known as the HT-IDE3000. The software provides an extremely user friendly Windows based approach for program editing and debugging while the ICE and e-ICE emulators and OCDS hardware provides full real time emulation with multi functional trace, stepping and breakpoint functions. With a complete set of interface cards for its full device range and regular software Service Pack updates, the IDE development environment ensures that designers have the best tools to maximize efficiency in the design and release of their microcontroller applications.

## IDE Development Environment

The Integrated Development Environment, otherwise known as the IDE, is a high performance integrated development environment designed around the company's series of 8-bit MCU devices. Incorporated within the system is the hardware and software tools necessary for rapid and easy development of applications based on the company range of 8-bit MCUs. The key component within the IDE system is the ICE, e-ICE or OCDS Emulators and Debuggers, capable of emulating the company 8-bit MCU in real time, in addition to providing powerful debugging and trace features. As for the software, the HT-IDE3000 provides a friendly workbench to ease the process of application program development, by integrating all of the software tools, such as editor, Cross Assembler, Cross Linker, library and symbolic debugger into a user friendly Windows based

environment. In addition, the HT-IDE3000 provides a software simulator for some devices which is capable of simulating the behavior of the company's 8-bit MCU range without connection to a hardware emulator.

More detailed information on the HT-IDE3000 development system is contained within the HT-IDE3000 User's Guide. Installed in conjunction with the HT-IDE3000 and to ensure that the development system contains information on new microcontrollers and the latest software updates, the company provides regular HT-IDE3000 Service Packs. These
Service Packs, which can be downloaded from the the company website, do not replace the
HT-IDE3000 but are installed after the HT-IDE3000 system software has been installed.

Some of the special features provided by the HT-IDE3000 include:

→ **Emulation**

- Real-time program instruction emulation

→ **Hardware**

**ICE**

- Easy installation and usage
- Either internal or external oscillator
- Breakpoint mechanism
- Trace functions and trigger qualification supported by trace emulation chip
- Printer port for connecting the ICE to a host computer
- I/O interface card for connecting the user's application board to the ICE

**e-ICE**

- Easy installation and usage
- Either internal or external oscillator
- Breakpoint mechanism
- USB cable for connecting the e-ICE to a host computer
- 2.54mm standard pins for connecting the user's application board to the e-ICE

**e-Link**

- The EV uses an OCDS - On-Chip Debug Support - architecture, which only requires two signal lines for debug
- The EV has the same number of pins as the IC or 1~2 more pins than the IC. It can be soldered to the application board and easily debugged.
- Contains several types of breakpoint functions
- Includes RAM real-time monitoring function
- Wide operating voltage range of 1.7V~5.5V

→ **Software**

- Windows based software utilities
- Source program level debugger - symbolic debugger
- Workbench for multiple source program files – allows for more than one source program file in one application project
- All tools are included for the development, debug, evaluation and generation of the final application program code
- Library for the setting up of common procedures which can be linked at a later date to other projects.

# In-Circuit Emulator - ICE, e-ICE and e-Link

Developed alongside the the company 8-bit microcontroller device range, the company ICE is a fully functional in-circuit emulator for the company's 8-bit microcontroller devices. Incorporated within the system are a comprehensive set of hardware and software tools for rapid and easy development of user applications. Central to the system is the in-circuit hardware emulator, capable of emulating all of the company's 8-bit devices in real-time, while also providing a range of powerful debugging and trace facilities. Regarding software functions, the system incorporates a user-friendly Windows based workbench which integrates together functions such as program editor, Cross Assembler, Cross Linker and library manager.

## ICE Interface Card

The interface cards supplied with the ICE can be used for most applications, however, it is possible for the user to omit the supplied interface card and design their own interface card. By including the necessary interface circuitry on their own interface card, the user has a means of directly connecting their target boards to the CN1 and CN2 connectors of the ICE.

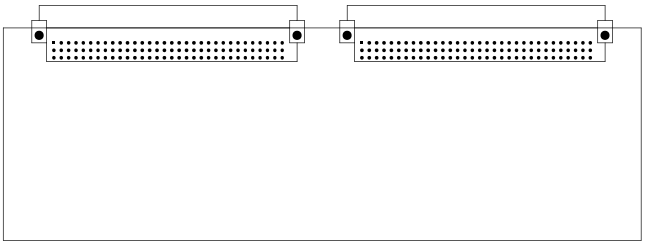


Fig 1-1

# System Configuration

The IDE system configuration is shown below, in which the host computer is a Pentium compatible machine with Windows 2000/XP or later. Note that if Windows 2000/XP or later systems are used, then the HT-IDE3000 software must be installed in the Supervisor Privilege mode.

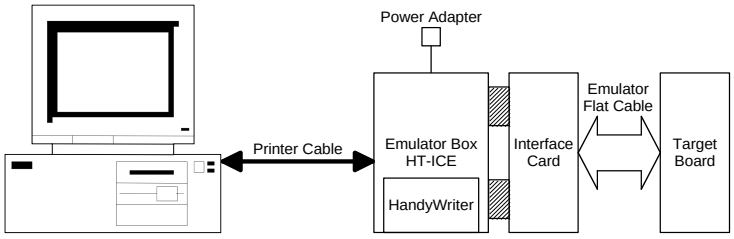



Fig 1-2

The IDE system contains the following hardware components:

**ICE**

- The ICE box contains the emulator box with 1 printer port connector for connecting to the host machine, I/O signal connector and one power-on LED
- I/O interface card for connecting the target board to the ICE box
- Power Adapter, output 16V
- 25-pin D-type printer cable
- Integrated MCU writer

**e-ICE**

- The e-ICE basically consists of two boards, a mother board, known as the MEV, and into which is plugged a device daughter board, known as the DEV.
- 5-pin Mini-B USB cable

**e-Link**

- e-Link device
- 2×6 double row male headers
- Flat-Cable pin connector 2×6 female headers - 25cm
- e-FPC06A
- USB cable
- Important note card
- Software CD

# Installation

## System Requirement

The hardware and software requirements for installing HT-IDE3000 system are as follows:

- PC/AT compatible machine with Pentium or higher CPU
- SVGA color monitor
- At least 256M RAM for best performance
- CD ROM drive (for CD installation)
- At least 200M free disk space
- Parallel or USB port to connect PC and ICE
- Windows XP/Vista/7

* Windows XP/Vista/7 are trademarks of Microsoft Corporation

## Hardware Installation

The company provides three kinds of ICE for the user to choose, as follows:

### ICE

- Step 1
  Plug the power adapter into the power connector of the ICE
- Step 2
  Connect the target board to the ICE by using the I/O interface card or flat cable
- Step 3
  Connect the ICE to the host machine using the printer cable. The LED on the ICE should now be lit, if not, there is an error and your dealer should be contacted.

---

**Caution**: Exercise care when using the power adapter. Do not use a power adapter whose output voltage is not 16V, otherwise the ICE may be damaged. It is strongly recommended that only the power adapter supplied by the company be used. First plug the power adapter to the power connector of the ICE.

---

### e-ICE

- Step 1

Install the correct DEV board for the MCU to be emulated

- Step 2

Use the USB cable to connect the e-ICE to the PC. The LED on the ICE should now be lit, if not, there is an error and your dealer should be contacted.

**e-Link**

- Step 1
  Connect the EV board to the e-Link using the flat cable
- Step 2
  Use the USB cable to connect the e-Link to the PC. The LED on the e-Link should now be lit, if not, it must be reconnected or contact your agent.

---

**Caution**: The HT-IDE3000 software version must be 7.6 or above when using the e-Link to debug.

---

## Software Installation

- Step 1
  First click on the HT-IDE3000 install icon to start the HT-IDE3000 installation.
- Step 2
  Press the <Next> button to continue setup or press <Cancel> button to abort.

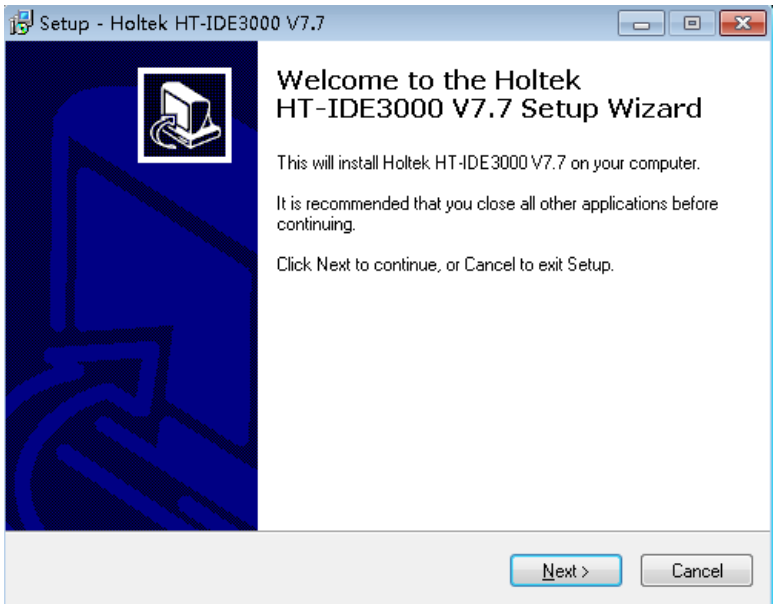

Setup - Holtek HT-IDE3000 V7.7
Welcome to the Holtek
HT-IDE3000 V7.7 Setup Wizard
This will install Holtek HT-IDE3000 V7.7 on your computer.
It is recommended that you close all other applications before continuing.
Click Next to continue, or Cancel to exit Setup.
Next >
Cancel

Fig 1-6

- Step 3
  The following dialogue will be shown to ask the user to enter a directory name.

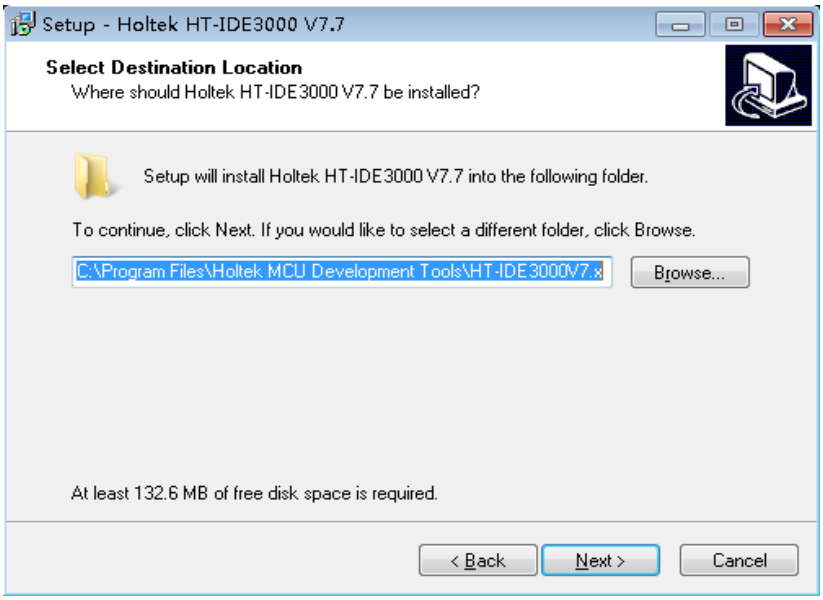

Setup - Holtek HT-IDE3000 V7.7
Select Destination Location
Where should Holtek HT-IDE3000 V7.7 be installed?
Setup will install Holtek HT-IDE3000 V7.7 into the following folder.
To continue, click Next. If you would like to select a different folder, click Browse.
C:\Program Files\Holtek MCU Development Tools\HT-IDE3000V7.x
Browse...
At least 132.6 MB of free disk space is required.
< Back
Next >
Cancel

Fig 1-7

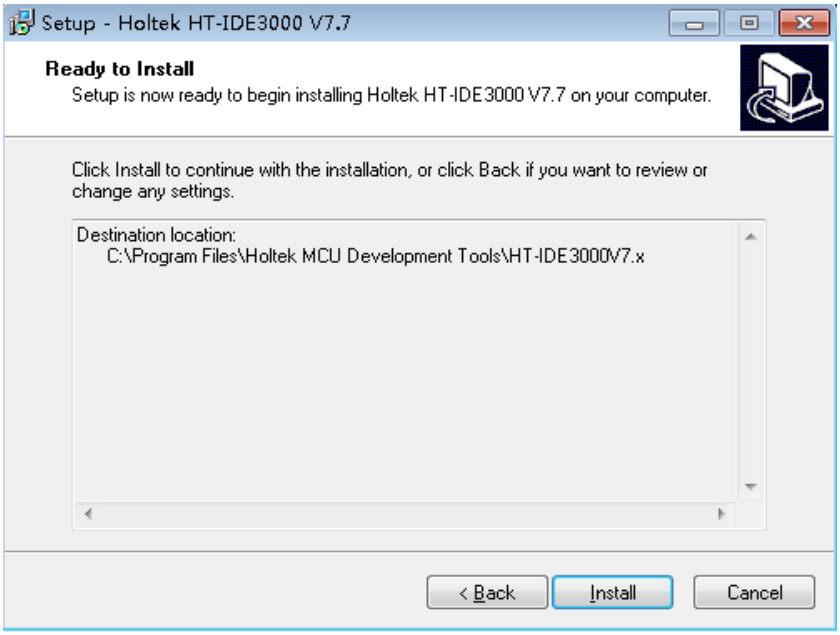

Setup - Holtek HT-IDE3000 V7.7
Ready to Install
Setup is now ready to begin installing Holtek HT-IDE3000 V7.7 on your computer.
Click Install to continue with the installation, or click Back if you want to review or change any settings.
Destination location:
C:\Program Files\Holtek MCU Development Tools\HT-IDE3000V7.x
< Back
Install
Cancel

Fig 1-8

- Step 4
  Specify the path you want to install the HT-IDE3000 to and click the <Next> button.
- Step 5
  SETUP will copy all files to the specified directory.

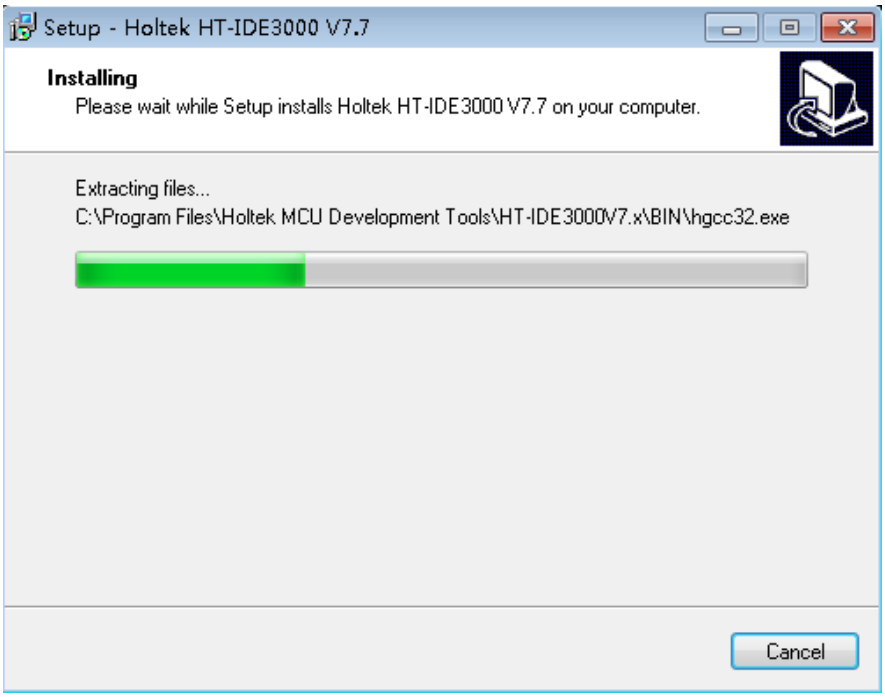

Setup - Holtek HT-IDE3000 V7.7
Installing
Please wait while Setup installs Holtek HT-IDE3000 V7.7 on your computer.
Extracting files...
C:\Program Files\Holtek MCU Development Tools\HT-IDE3000V7.x\BIN\hgcc32.exe
Cancel

Fig 1-9

- Step 6

  If the process is successful the following dialogue box will be shown.

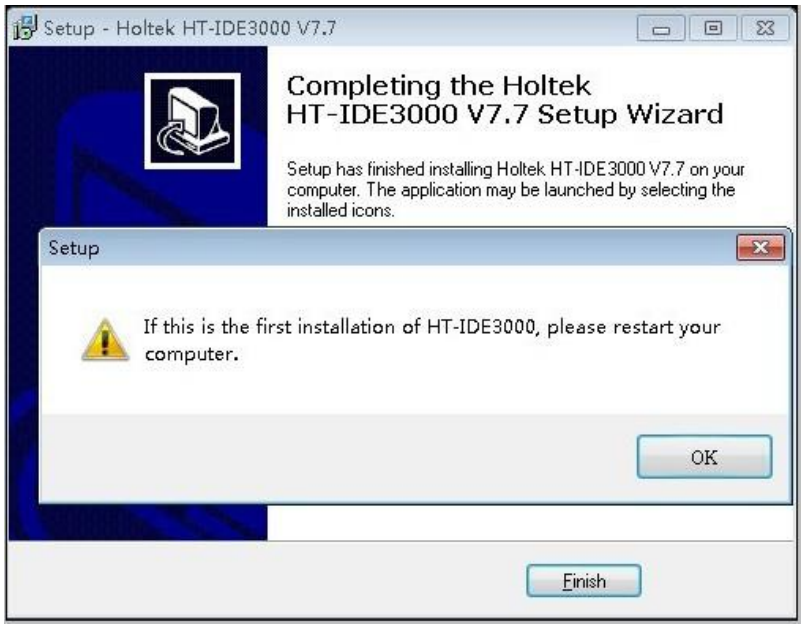

Setup - Holtek HT-IDE3000 V7.7
Completing the Holtek HT-IDE3000 V7.7 Setup Wizard
Setup has finished installing Holtek HT-IDE3000 V7.7 on your computer. The application may be launched by selecting the installed icons.
Setup
If this is the first installation of HT-IDE3000, please restart your computer.
OK
Finish

Fig 1-10

- Step 7

  Press the <OK> button and then press the <Finish> button to finish the setup. If this is the first installation of HT-IDE3000, please restart the computer system.

## Driver digital signature

During the setup, note that the driver digitial signature is a protection mechanism for Win7 driver installation. If a problem should occur the solution is as follows:

Restart the computer, then press the F8 key, select "Disable Driver Signature Enforcement" to enter the system, and then setup the HT-IDE3000. In addition, if the ICE can not be connected, it also needs to select "Disable Driver Signature Enforcement" to enter the system.

Chapter2

# Quick Start

2

This chapter gives a brief description of using HT-IDE3000 to develop an application project.

## Step 1：Create a New Project with the CodeWizard

- Click on the Project menu and select New command
- Enter a project name and select an MCU from the combo box
- Choose the file type from either .ASM or .C.
- Click on the Next button and the system will ask you to setup the configuration options
- Setup all configuration options and click on the OK button.
- Finally, click OK when you have confirmed the Project Setting options.

## Step 2：Build the Project

- Click on Build menu and select the Build command
- The system will assemble/compile all source files in the project
  - If there are errors in the programs, double click on the error message line and the system will prompt you to the position where the error has occurred.
  - If all the program files are error free, the system will create a Task file and download it to the ICE for debug.
- These steps can be repeated until the program is fully debugged.

## Step 3：Programming the MCU Device

- Build the project to create the .OTP file
- Use the general-purpose writer e-WriterPro together with the HOPE3000 to program the MCU devices.

## Step 4：Transmit Code to the company

- Click on the Project menu and select the Option Table Viewer command. Fig 2-1 will then be displayed, after which click on the Print button to print the configuration options.
- Send the .COD file and the Option Approval Sheet to the company.

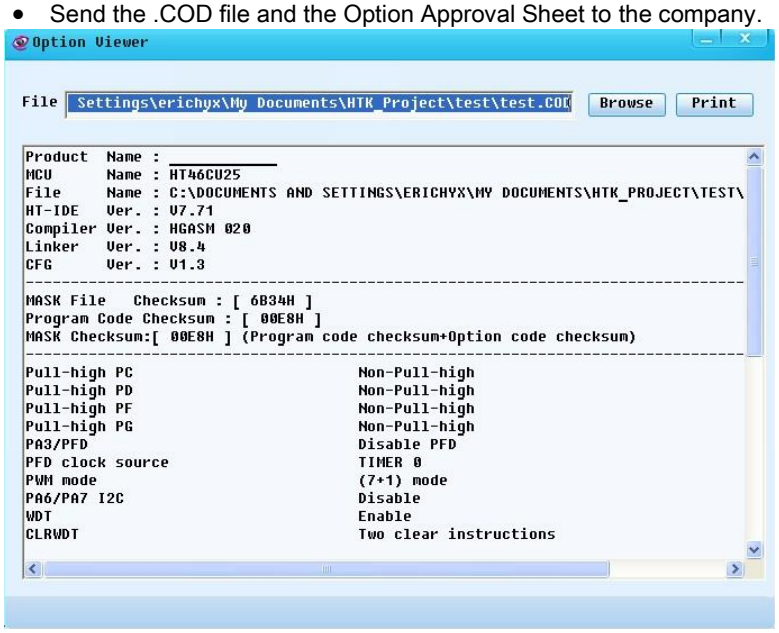



Fig 2-1

The Programming and data flow is illustrated by the following diagram:

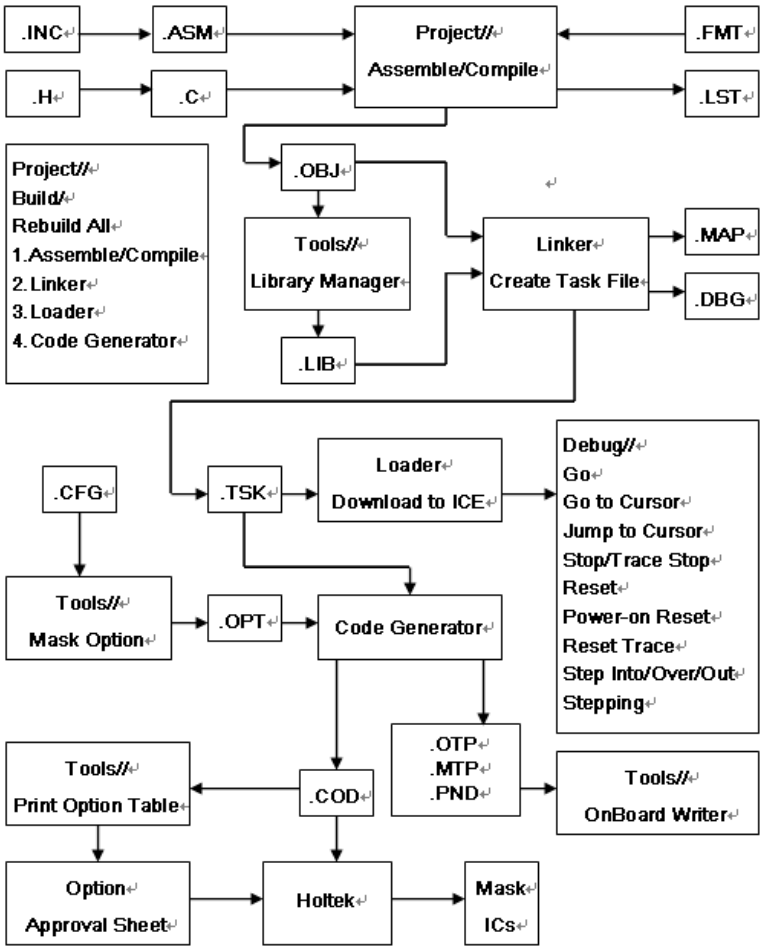

.INC
.ASM
Project//
Assemble/Compile
.FMT
.H
.C
.LST
Project//
Build/
Rebuild All
1.Assemble/Compile
2.Linker
3.Loader
4.Code Generator
.OBJ
Tools//
Library Manager
Linker
Create Task File
.MAP
.DBG
.LIB
.CFG
.TSK
Loader
Download to ICE
Debug//
Go
Go to Cursor
Jump to Cursor
Stop/Trace Stop
Reset
Power-on Reset
Reset Trace
Step Into/Over/Out
Stepping
Tools//
Mask Option
.OPT
Code Generator
.OTP
.MTP
.PND
Tools//
Print Option Table
.COD
Tools//
OnBoard Writer
Option
Approval Sheet
Holtek
Mask
ICs

Fig 2-2

Chapter 3

# Menu – File/Edit/View/Tools/Options

3

This chapter describes some of the menus and commands of the HT-IDE3000. Other menus are described in the Project, Debug and Window chapters.

## Start the HT-IDE3000 System

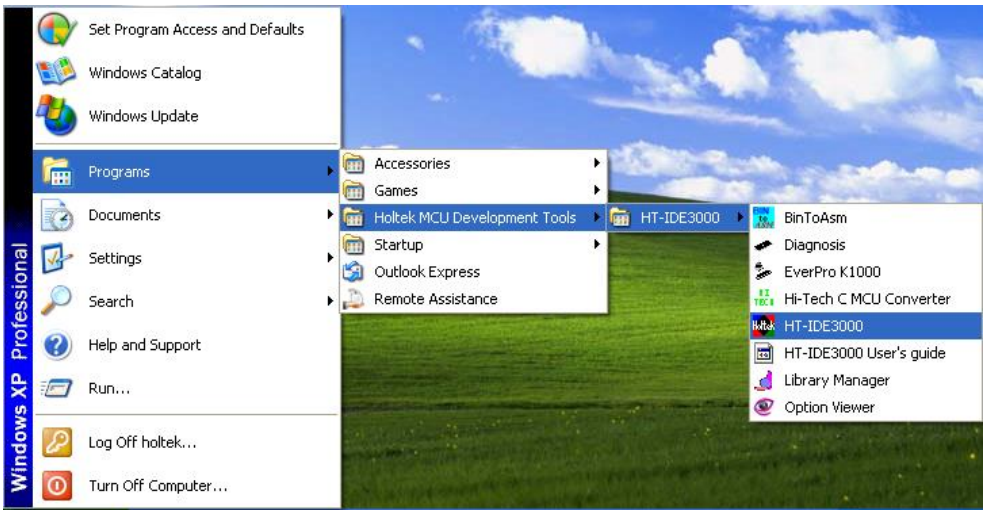



Fig 3-1

- Click the Start Button, select Programs and select HT-IDE3000
  - Click the HT-IDE3000 icon

- Fig 3-2 will be displayed if the following conditions occur.
  - No connection between the ICE and the host machine or connection fails.
  - The ICE is powered off.

Fig 3-2

If “Retry” is selected and the connection between the ICE and the host machine has been made, then Fig 3-3 will be displayed, the HT-IDE3000 will enter the emulation mode and the ICE begins to function.

Fig 3-3

The HT-IDE3000 software includes File, Edit, View, Project, Build, Debug, Tools, Options, Window and Help menus. The following sections describe the functions and commands of each menu.

A dockable toolbar, below the menu bar (Fig 3-4), contains icons that correspond to, and assist the user with more convenient execution of frequently used menu

commands. When the cursor is placed on a toolbar icon, the corresponding command name will be displayed alongside. Clicking on the icon will cause the command to be executed.

A Status Bar, in the bottom line (Fig 3-4), displays the emulation or simulation present status and the resulting command status. In the status bar, the field (PC=0001H) displays the Program Counter while in debugging process (Debug menu).

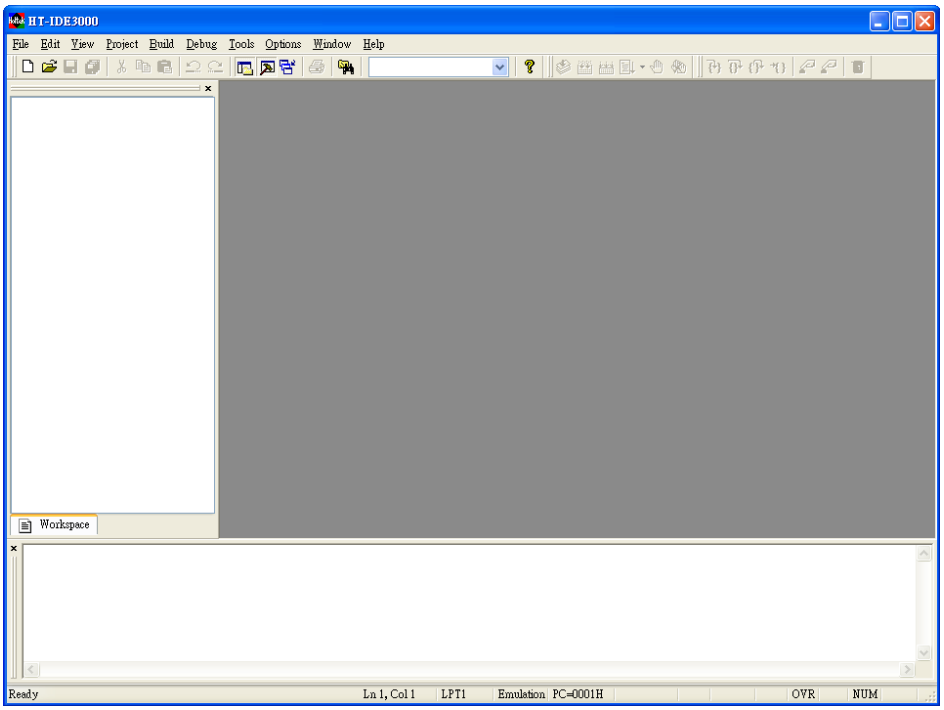



Fig 3-4

The Status Bar contains information that may be useful during program debug. The Program Counter is used during program execution and indicates the actual present Program Counter value while the row and column indicators are used to show the present cursor position when using the program editor.

# File Menu

The File menu provides file processing commands, the details behind which are shown in the following list along with the corresponding toolbar icons.

- New

  Create a new file
- Open

  Open an existing file
- Close

Close the current active file

- Save

  Write the active windows data to the active file
- SaveAs

  Write the active windows data to the specified file
- Save All

  Write all windows data to the corresponding opened files
- Print

  Print active data to the printer
- Print Setup

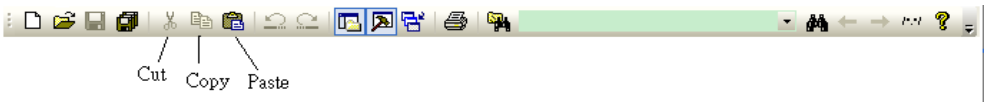
  Setup printer
- PrintPreview

  Preview the printed output
- Recent Files

  List the most recently opened and closed four files
- Exit

  Exit from HT-IDE3000 and return to Windows

# Edit Menu




- Undo

  Cancel the previous editing operation
- Redo

  Cancel the previous Undo operation
- Cut

  Remove the selected lines from the file and place onto the clipboard
- Copy

  Place a copy of the selected content onto the clipboard
- Paste

  Paste the clipboard information to the present insertion point
- Delete

  Delete the selected content

- Select All
  Select the entire document
- Find
  Search the specified word from the editor active buffer
- Find Next
  Find the next occurrence of the specified text
- Find Previous
  Find the previous occurrence of the specified text
- Find in Files
  Search for a string in multiple files
- Replace
  Replace the specified source word with the destination word in the editor active buffer
- Go To…
  Moves to a specified location
- Read Only
  Read only mode

## View Menu

The View menu provides the following commands to control the window screen of the HT-IDE3000. (Refer to Fig 3-5)

- Full Screen
  Toggles Full Screen Mode on/off
- Appliaction Look
  Multiple styles can be selected: Windows 2000, Office XP, Windows XP, Office 2003, Visual Studio .Net 2005, Office 2007(including blue, black, sliver and green), Visual Studio .Net 2005 is as the default.
- Restore Default LayOut
  Restore the default layout, this command will restart the program automatically.
- Toolbar
  Display the toolbar information on the window. The toolbar contains some groups of buttons whose function is the same as that of the command in each corresponding menu item. When the mouse cursor is placed on a toolbar button, the corresponding function name will be displayed next to the button. If the mouse is clicked, the

command will be executed. Refer to the corresponding chapter for the functionality of each button. The Toggle Breakpoint button will set the line specified by the cursor as a breakpoint (highlighted). The toggle action of this button will clear the breakpoint function if previously set.

- Status Bar

  Displays the status bar information on the window.
- Display Line Numbers

  Toggle line numbering on and off in your code.
- Cycle Count

  Count instruction cycles accumulatively. Press the reset button to clear the cycle count. The Hex and Dec buttons are used to change the radix of the count, hexadecimal or decimal. The maximum cycle count is 65535.

---

**Note:** There is a slight difference of maximum cycle count between two kinds of ICE, the maximum cycle count of e-ICE can up to 4294967295 while ICE can only count to 65535.

---

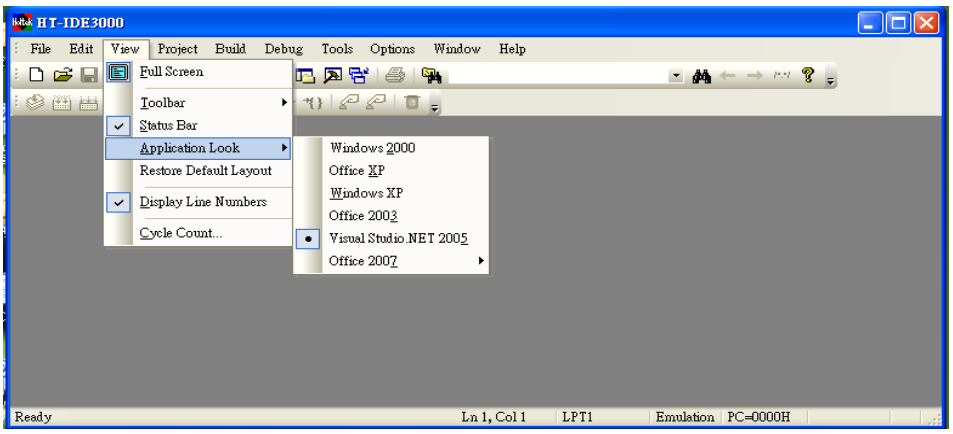



Fig 3-5

# Tools Menu

The Tools menu provides the special commands to facilitate user application debug. These commands are Configuration Options, Import Configuration Options, Diagnose, Writer, Library Manager, Editor, LCD Simulator, Voice & Flash Download and Switch OCDS Mode.

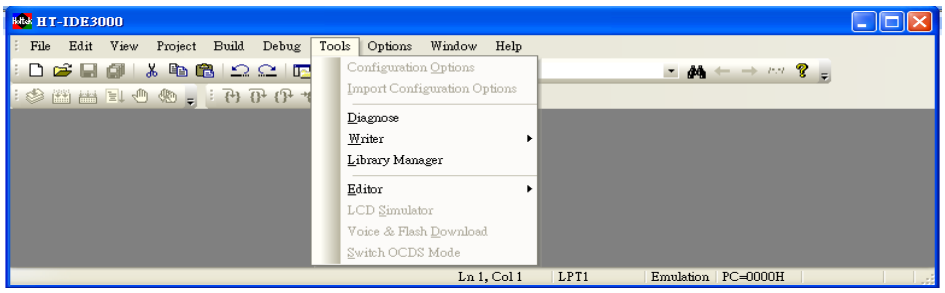



Fig 3-6

## Configuration Option

This command generates an option file used by the Build command in the Build menu. The contents of the option file depend upon the specified MCU. This command allows options to be modified after creation of the project.

→ **Choosing the Clock Source**

When creating a new project or modifying the configuration options, it is necessary to choose an internal or external clock source for ICE.

If an internal clock source is used, the system application frequency has to be specified. The HT-IDE3000 system will calculate a frequency which can be supported by the ICE, one which will be the most approximate value to the specified system frequency. Whenever the calculated frequency is not equal to the specified frequency, a warning message and the specified frequency along with the calculated frequency will be displayed. Confirmation will then be required to confirm the use of the calculated frequency or to specify another system frequency. Otherwise an external clock source is the only option. No matter which kind of clock source is chosen, the system frequency must be specified.

---

**Note:** More information about choosing the clock source for e-ICE, please refer to the e-ICE User's Guide.

---

## Import Configuration Options

Import the configuration options files.

## Diagnose

This command (Fig 3-7) helps to check whether the ICE is working correctly. There are a total of 9 items for diagnosis. Multiple items can be selected by clicking the check box and pressing the Test button, or press the Test All button to diagnose all items. These

items are listed below.

- MCU resource option space
  - Diagnose the MCU options space of the ICE.
- Code space
  - Diagnose the program code memory of the ICE.
- Trace space
  - Diagnose the trace buffer memory of the ICE.
- Data space
  - Diagnose the program Data Memory of the ICE.
- System space
  - Diagnose the system Data Memory of the ICE.
- I/O EV 0
  - Diagnose the I/O EV-chip in socket 0 of the ICE.
- I/O EV 1
  - Diagnose the I/O EV-chip in socket 1 of the ICE.
- I/O EV 2
  - Diagnose the I/O EV-chip in socket 2 of the ICE.
- I/O EV 3
  - Diagnose the I/O EV-chip in socket 3 of the ICE.

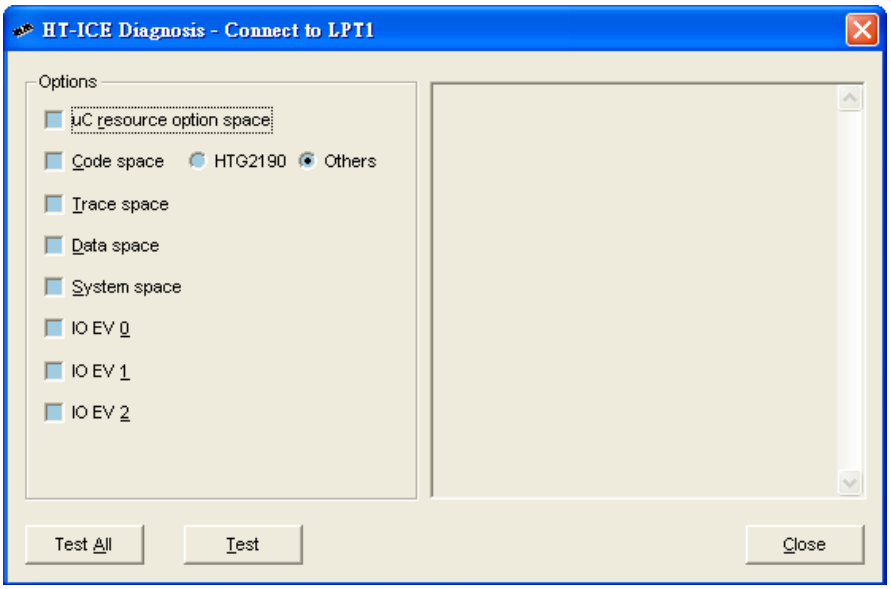



Fig 3-7

## Library Manager

The Library Manager command, in Fig 3-8, supports the library functions. Program codes used frequently can be compiled into library files and then included in the application program by using the Project command in the Options menu. (Refer to the Cross Linker options item in the Options menu, Project command). The functions of Library Manager are:

- Create a new library file or modify a library file
- Add/Delete a program module into/from a library file
- Extract a program module from a library file, and create an object file

Part III gives more details on the library manager.

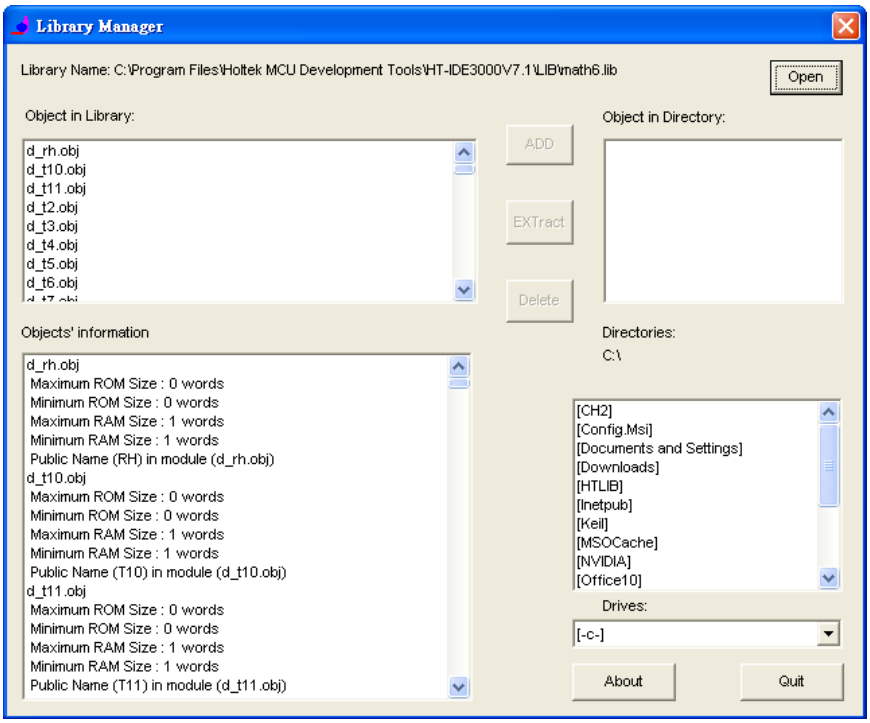



Fig 3-8

## Holtek C V2-->V3 syntax converter

As Holtek's C V2 and C V3 have different syntax, this converter can assist with the conversion of C V2 projects to C V3 projects. The main screen is shown in in Fig 3-9

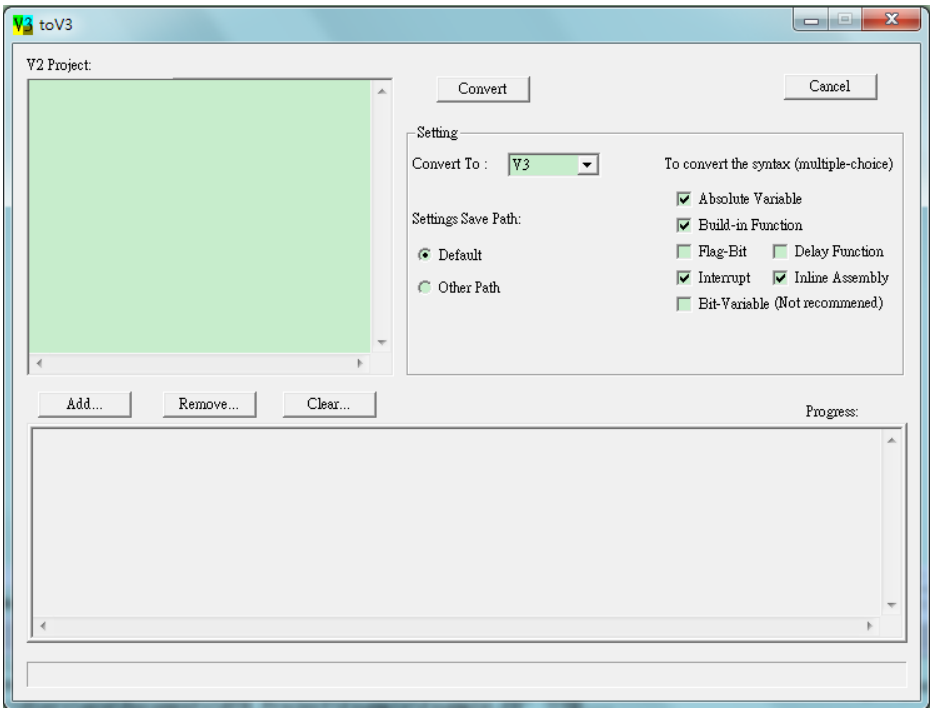



Fig 3-9

1. Add

   Add a project for conversion. More than one can be added at a single time allowing multiple projects to be converted at the same time

2. Remove

   Delete the selected project

3. Clear

   Clear all projects

4. Convert

   Start Conversion

5. Convert To

   This only support conversion to Holtek C V3

6. Settings Save Path

   Save the path of the converted project

   1) Default

      Automatically generates a folder named V3 in the original project folder

   2) Other Path

      Stored in the user specified path

7. To convert the syntax (multiple-choice)

   The syntax to be converted is listed below:

   1) Absolute Variable

   A variable is designated to the fixed address, for example: char a @0x80;

   2) Built-in Function

   For example: _clrwdt()

   3) Flag-Bit

   For example: _80_1

   4) Delay Function

   The built-in function: _delay()

   5) Interrupt

   Interrupt function

   6) Inline Assembly

   Embedded assembly language, for example:

   #asm

   #endasm

   7) Bit-Variable

   For example:bit a;

## Program Location Manager

The position of each module in the memory can be setup by the user, see Fig 3-10.

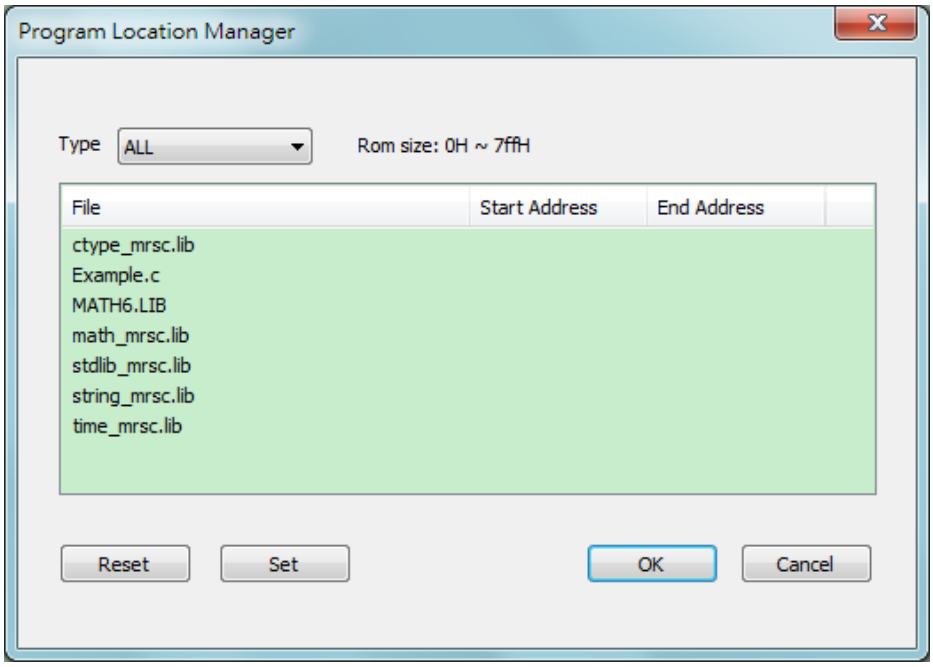



Fig 3-10

1.Type

Types of module. These can be C, ASM, OBJ or LIB.

2.Set

Select modules in listbox (use the Shift key or Ctrl key to select more than one module) and then click the Set button. This will generate the following dialog:

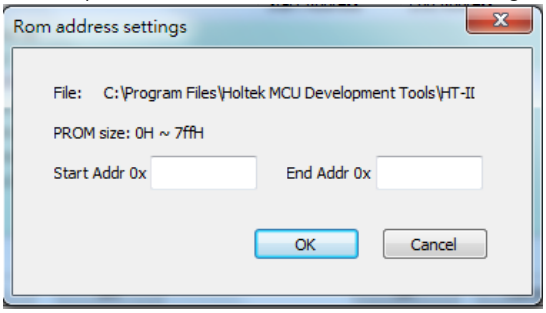



Fig 3-11

Finally enter the start address and end address.

Tip: Removing the start address and the end address can reset the module settings

3.Reset

Clear all settings

Additionally this can be setup from the workspace.

.

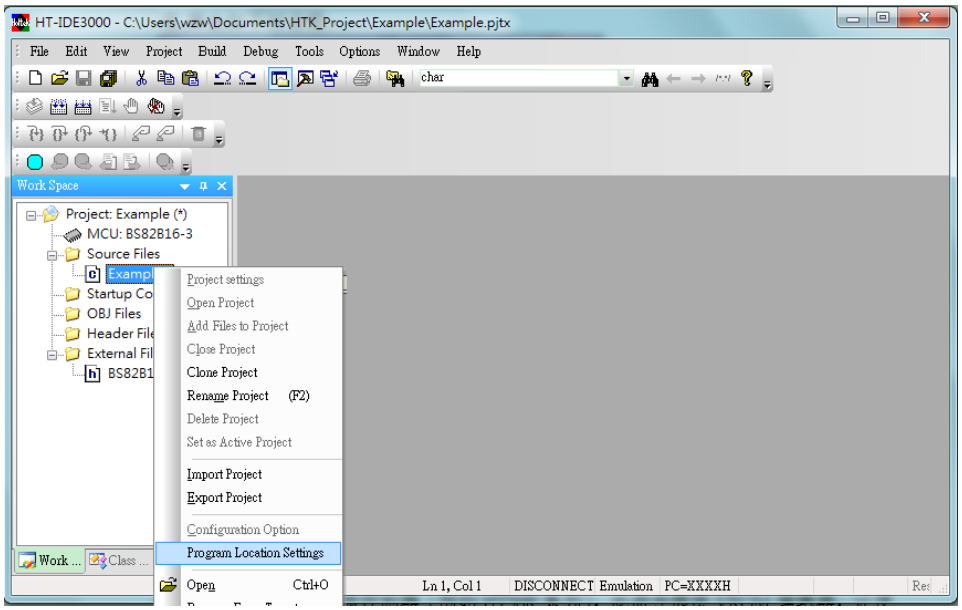



Fig 3-12

## Editor

- **Voice ROM Editor**
  - The company provides a VROM Editor for the user to arrange the voice code for the specific MCU (eg. The HT86 series)

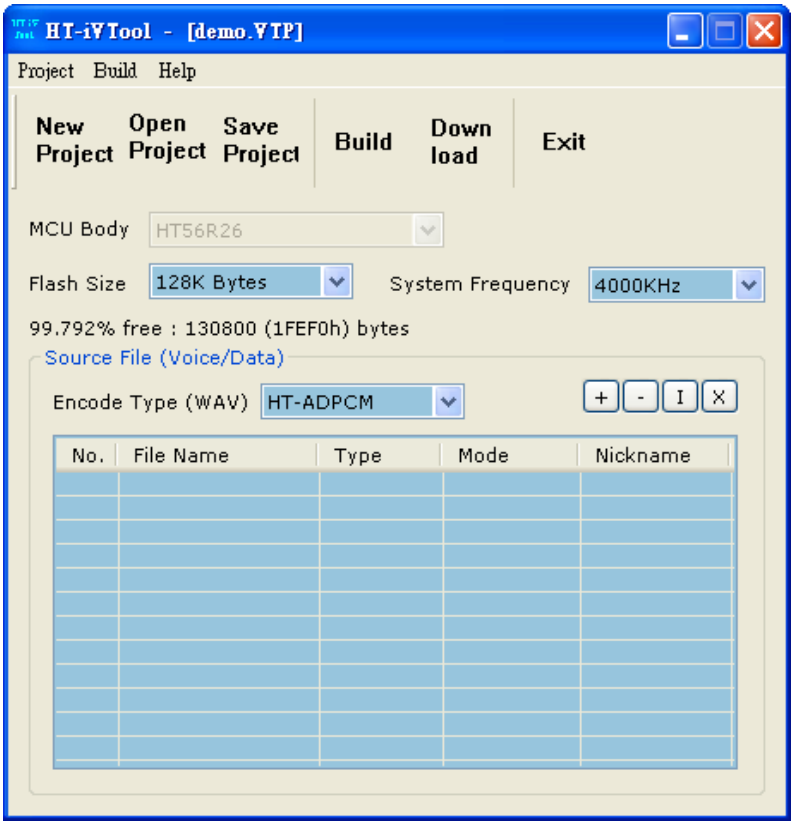



Fig 3-13

- **Data Editor**
  - Some the company MCUs (eg. the HT48E series) include internal EEPROM memory. The Data EEPROM Editor provides an interface for the user to arrange the data and download/upload the data to/from the ICE.

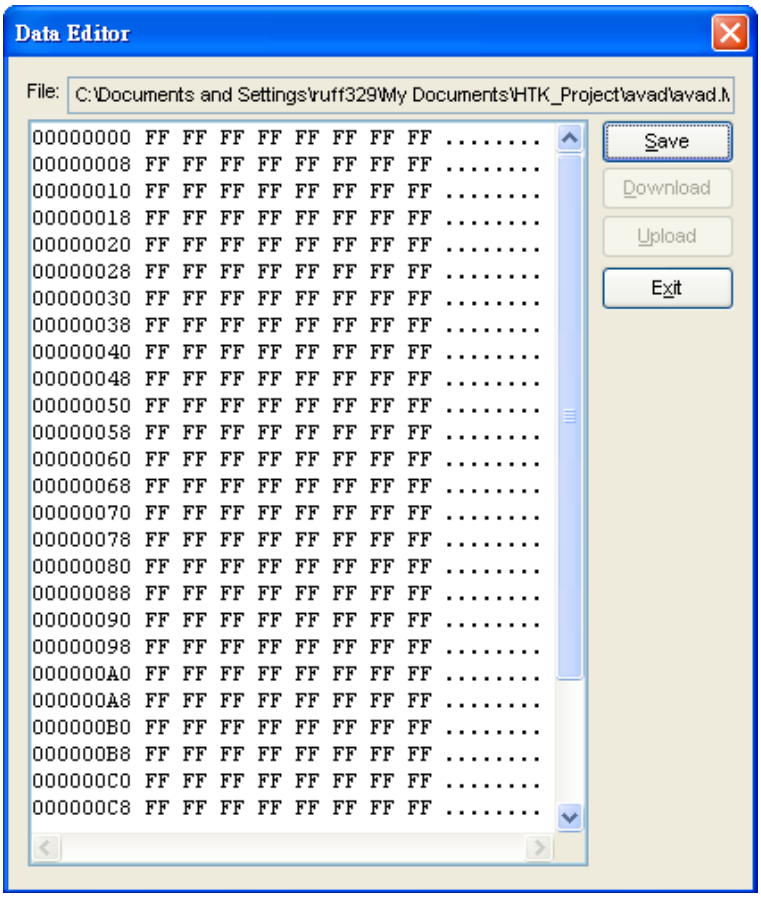

Data Editor
File:
C:\Documents and Settings\ruff329\My Documents\HTK_Project\avad\avad.h
00000000 FF FF FF FF FF FF FF FF ........
00000008 FF FF FF FF FF FF FF FF ........
00000010 FF FF FF FF FF FF FF FF ........
00000018 FF FF FF FF FF FF FF FF ........
00000020 FF FF FF FF FF FF FF FF ........
00000028 FF FF FF FF FF FF FF FF ........
00000030 FF FF FF FF FF FF FF FF ........
00000038 FF FF FF FF FF FF FF FF ........
00000040 FF FF FF FF FF FF FF FF ........
00000048 FF FF FF FF FF FF FF FF ........
00000050 FF FF FF FF FF FF FF FF ........
00000058 FF FF FF FF FF FF FF FF ........
00000060 FF FF FF FF FF FF FF FF ........
00000068 FF FF FF FF FF FF FF FF ........
00000070 FF FF FF FF FF FF FF FF ........
00000078 FF FF FF FF FF FF FF FF ........
00000080 FF FF FF FF FF FF FF FF ........
00000088 FF FF FF FF FF FF FF FF ........
00000090 FF FF FF FF FF FF FF FF ........
00000098 FF FF FF FF FF FF FF FF ........
000000A0 FF FF FF FF FF FF FF FF ........
000000A8 FF FF FF FF FF FF FF FF ........
000000B0 FF FF FF FF FF FF FF FF ........
000000B8 FF FF FF FF FF FF FF FF ........
000000C0 FF FF FF FF FF FF FF FF ........
000000C8 FF FF FF FF FF FF FF FF ........
Save
Download
Upload
Exit

Fig 3-14

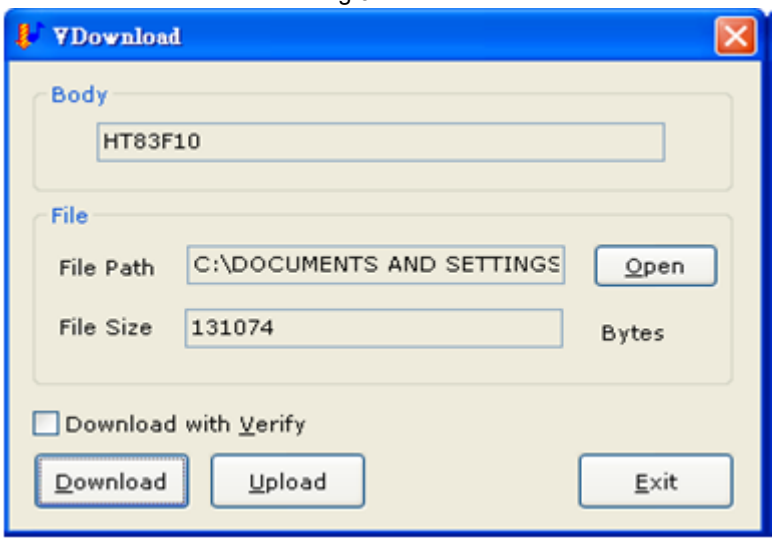



Fig 3-15

## LCD Simulator

The LCD simulator, LCDS, provides a mechanism to simulate the output of the LCD driver. According to the designed patterns and the control programs, the LCDS displays the patterns on the screen in real time. LCD Simulator only supports part of MCUs based on the ICE architecture. Additionally, this part is no longer being updated.

## Voice & Flash Download

The Voice & Flash Download downloads the contents of a specified voice data file with the extension .VOC or .DAT to the ICE for emulation or burn the voice data to SPI Flash by e-Writer. It also uploads from ICE VROM or SPI Flash saving the data to a specified .VOC or .DAT file. Fig 3-15 displays the dialog box which shows the name of the download voice .VOC, which was generated by the VROM editor. The File Size box, below the File Path box, displays the voice ROM size in bytes for microcontroller device in the current project. Ensure that the voice file .VOC has been generated by the VROM editor before downloading.

## Switch OCDS Mode

This command is only used for OCDS-ICE, two modes can be selected here and correspond to different package types respectively. (Fig 3-16).

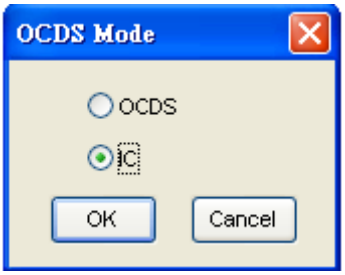



Fig 3-16

## Smart Programming Settings

This function is available for OTP and MTP type MCUs.

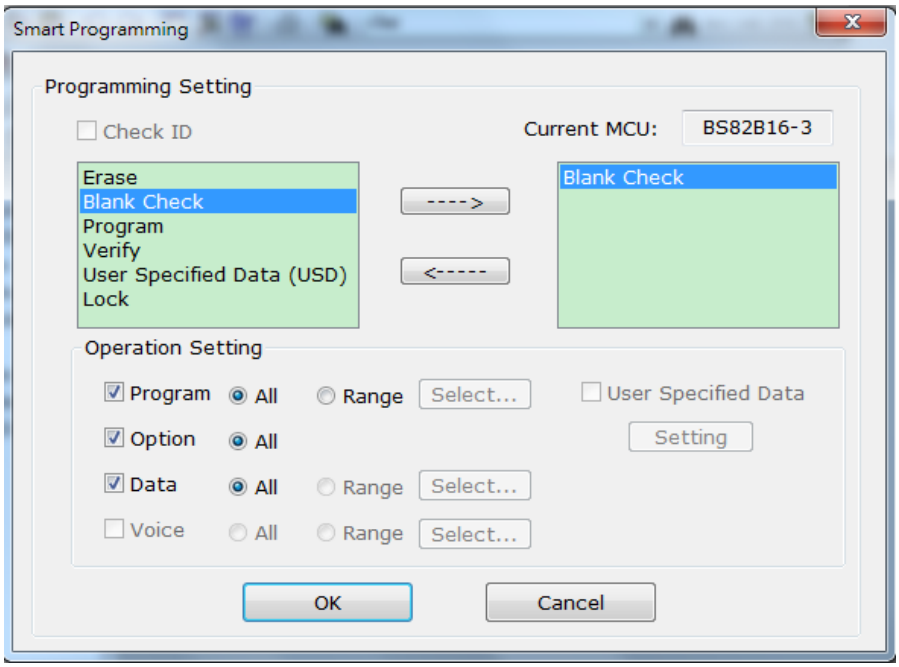



Fig 3-17

This function refers to Chapter four in the HOPE3000 documentation.

## Options Menu

The Options menu (Fig 3-18) provides the following commands which can set the working parameters for other menus and commands.

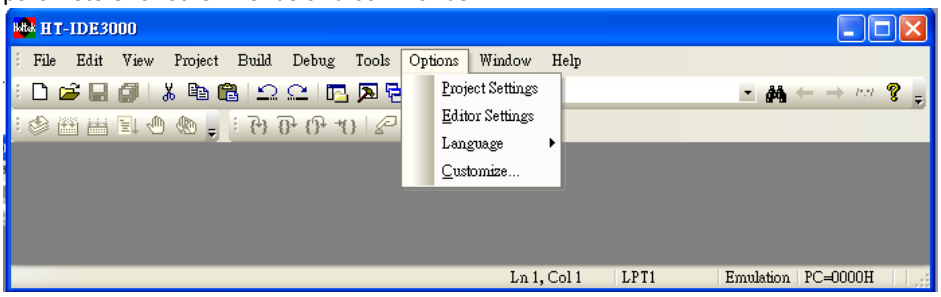



Fig 3-18

## Project Settings

→ **Project Option**

The Project Option sets the default parameters used by the Build command in the Project menu. During development, the project options may be changed according to the needs of the application. According to the options set, the HT-IDE3000 will generate a proper task file for these options when the Build command of the Project menu is issued. The dialog box (Fig 3-19) is used to set the Project options.

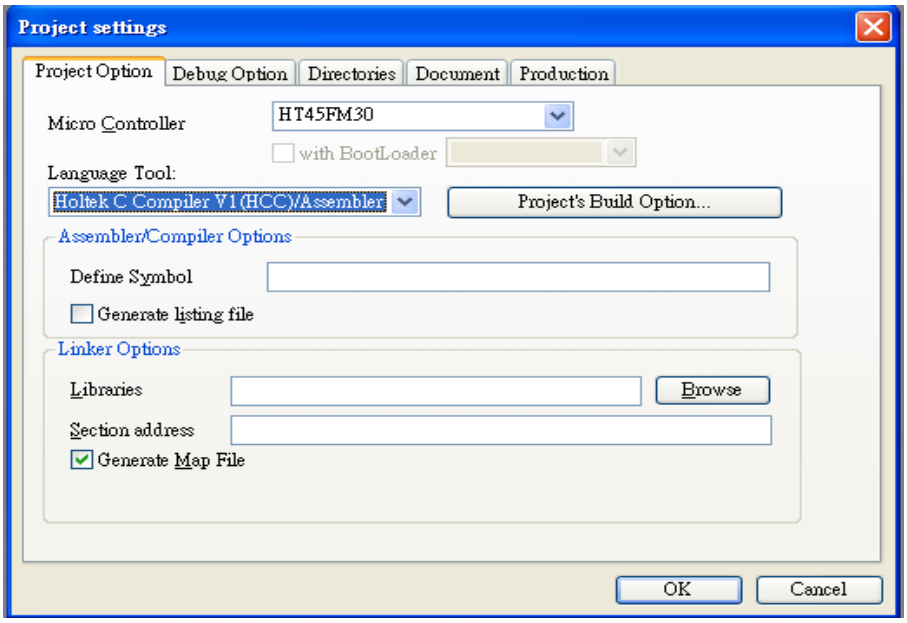



Fig 3-19

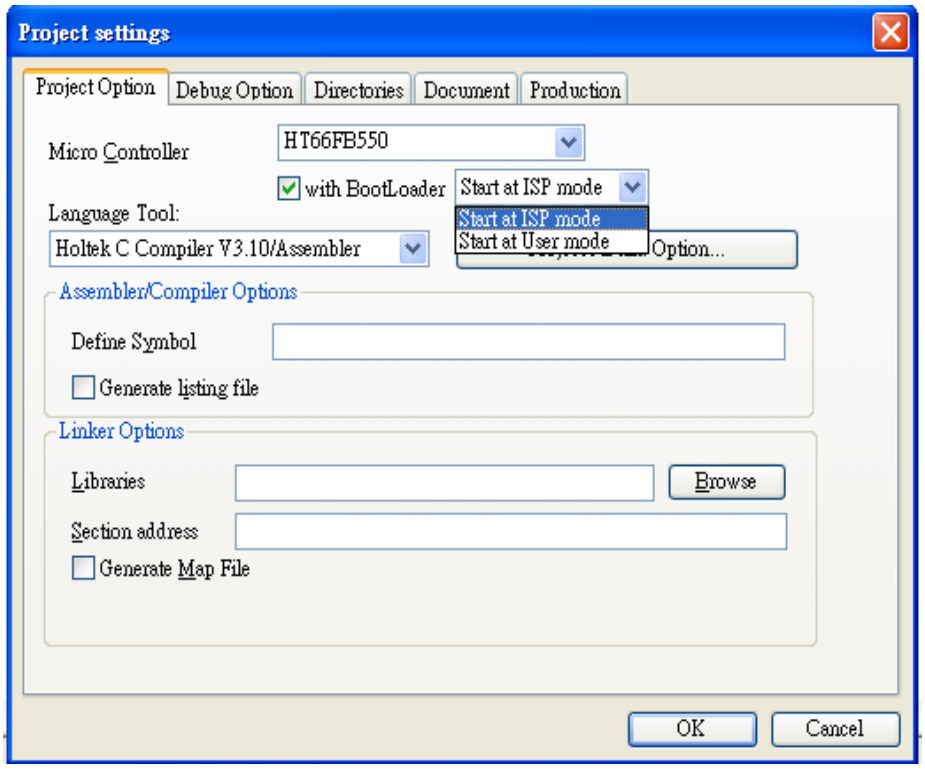



Fig 3-20

**Note:** Before issuing the Build command, ensure that the project options are set correctly.

- Micro Controller

  The chosen MCU for this project is selected here. Use the scroll arrow to browse the available MCUs and select the appropriate one.

- With Bootloader

  This function is only suitable for the USB Flash MCU series.

  Check the With BootLoader box when programming in the ISP mode and then select the program block which is first executed when powered on.

  Start at the ISP mode then excute the BootLoader program block first when powered on Wait until the AP excutes the USB Link, then jump to the User code block when the update is finished.

  Start at theUser mode then excute the User code block first when powered on. Only if an update is necessary will it call the Library and return to the BootLoader to update. It

will jump to the new User code block when the update is finished.

- Project's Build Option

  Clicking on the button will cause the configuration dialog box to be displayed. This is used to set the Complier options.

- Language Tool

  The company permits Third Parties to provide C compilers for the company's MCUs. Here the Hi-Tech language tool can be selected as an alternative choice.

- Assembler/Compiler Options

  The command line options of the Cross Assembler. Define symbol allows users to define values for specified symbols used in assembly programs. The syntax is as follows:

  **symbol1[=value1] [,symbol2 [=value2] [,...]]**

  For example：

  debugflag=1, newver=3

  The check box of the Generate listing file is used to check if the source program listing file has been generated.

- Linker options

  To specify the options of the Cross Linker. Libraries are used to specify the library files refered by Cross Linker.For example：

  libfile1, libfile2

  Library files can be selected by clicking the Browse button.
  Section address is used to set the ROM/RAM addresses of the specified sections, for example：

  codesec=100, datasec=40

  The check box of the Generate map file is used to check if the map file of Cross Linker is generated.

→ **Debug Command**

This command sets the options used by the Debug menu. The dialog box (Fig 3-21) lists all the debug options with check boxes. By selecting the options and pressing the OK button, the Debug menu can then obtain these options during the debugging process.

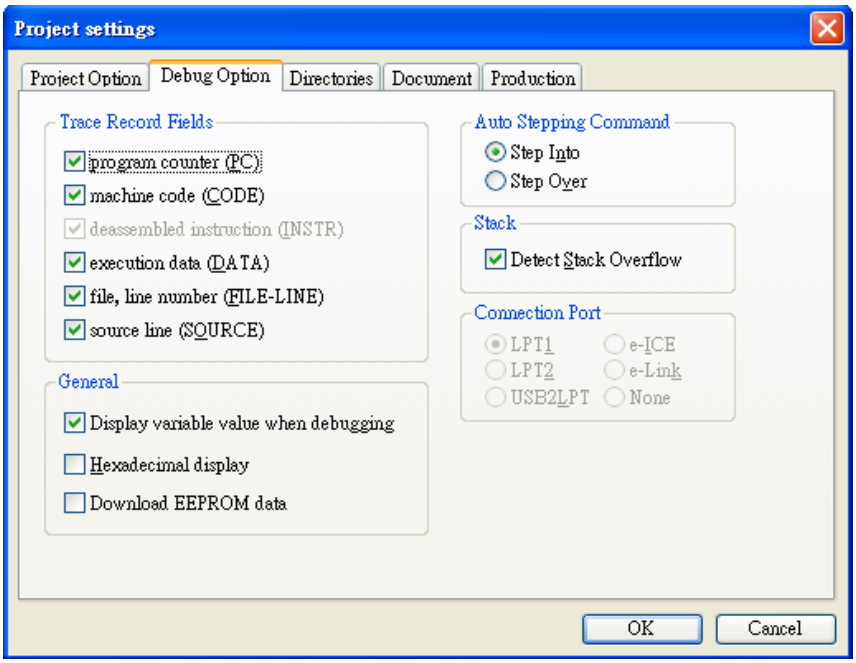



Fig 3-21

- Trace Record Fields

  This location specifies the information to be displayed when issuing the Trace List command, contained within the Window menu. For each source file instruction, the information will be displayed in the same order as that of the items in the dialog box, from top to the bottom. If no item has been selected, the next selected item will be moved forward. The default trace list will display the file name and line number only. The de-assembled instruction is obtained from the machine code, and the source line is obtained from the source file.

- General

  Several items are used to display certain actions when in the debug mode, such as displaying variable values, hexadecimal displays and downloading EEPROM data. The Download EEPROM data check box is only checked when the selected IC has an EEPROM function. If the check box is checked, the EEPROM will be downloaded to the hardware simulator automatically when executing the Build command.

- Auto Stepping Command

  Selects the automatic call procedure step option, namely Step Into or Step Over. Only one option can be selected.

- Stack

  Uncheck this Detect Stack Overflow box if you do not want the system to show a

message while detecting a stack overflow.

- Connection Port

  Display the PC connection port for the ICE. The connection port has no effect if the simulation mode is selected.

→ **Directories Command**

The command sets the default search path and directories for saving files. (Fig 3-22)

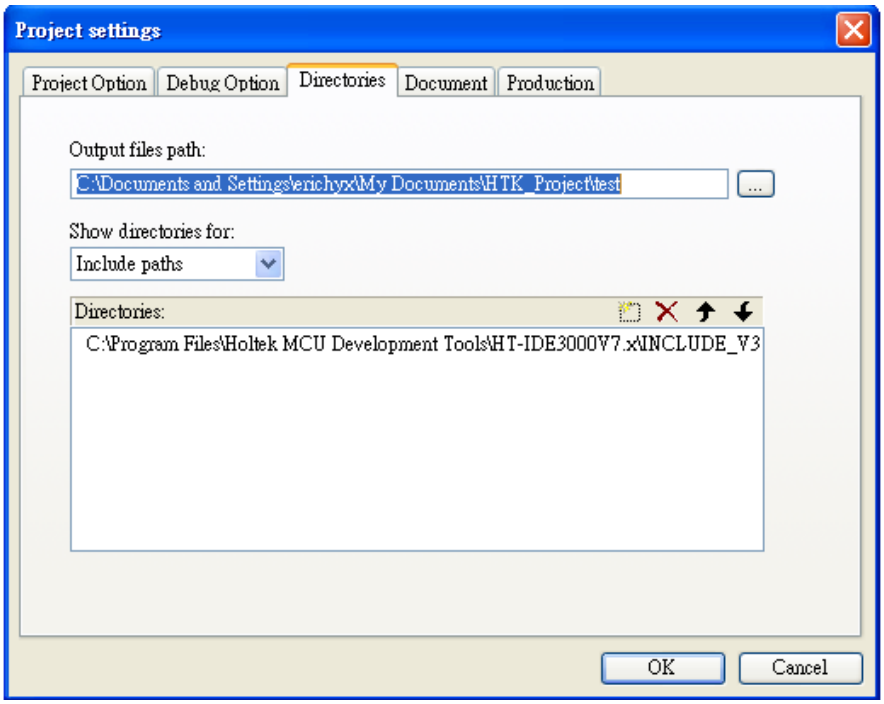



Fig 3-22

- Include paths

  The search path referred to by the Cross Assembler to search for the included files.

- Library paths

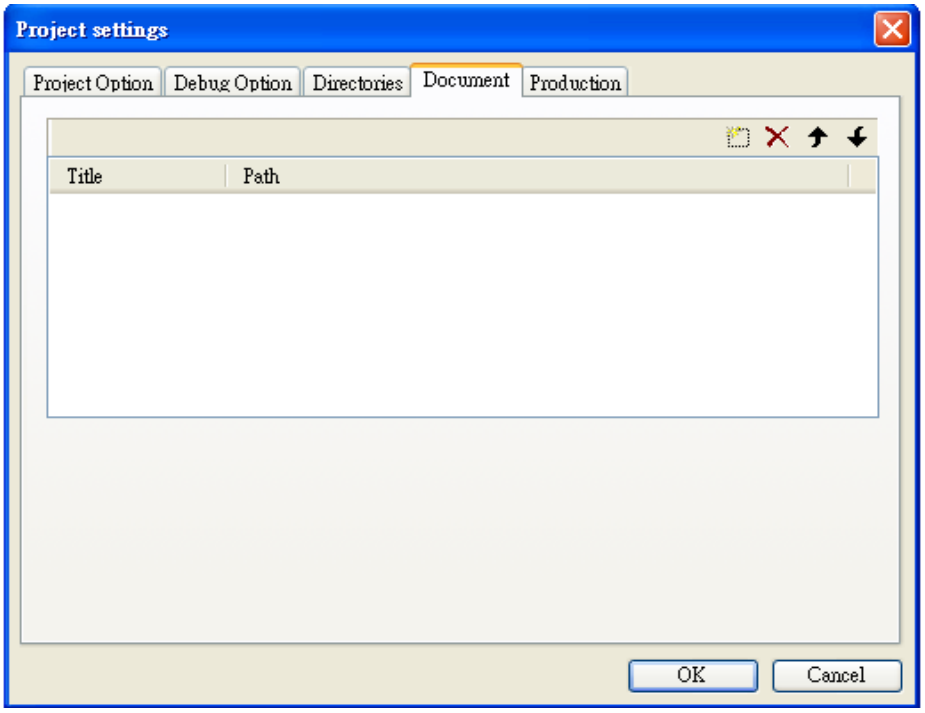
  The search path referred to by the Cross Linker to search for the library files.

- Output files path

  The directory for saving the output files of the Cross Assembler (.obj, .lst) and Cross Linker (.tsk, .map, .dbg)

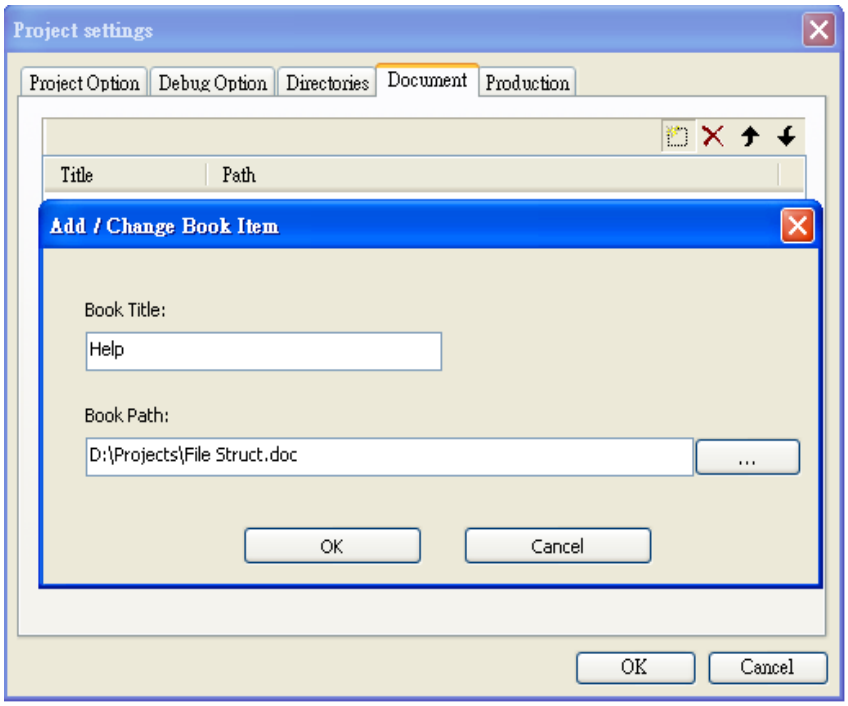
→ **Document**

This command is used to add documents to the project. When documents are added, they will be listed on the Documents window on the left hand side as shown in Fig


Project settings
Project Option
Debug Option
Directories
Document
Production
Title
Path
OK
Cancel

3-25.

Fig 3-23



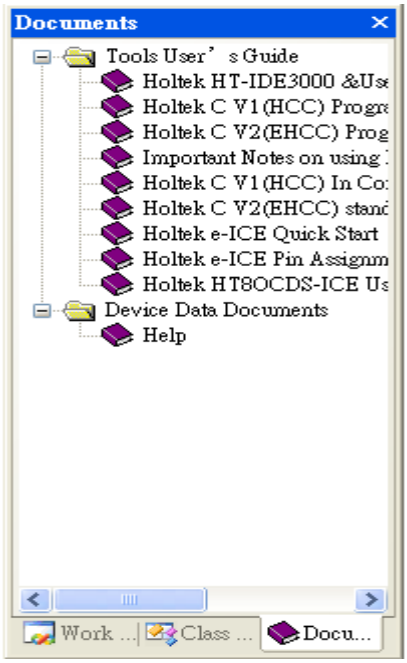




Fig 3-24

Fig 3-25

→ **Production**

In order to let users know which IC has been locked, the HT-IDE3000 provides an identification code function as shown in Fig 3-26.

When the setput is finished, the identification code will be written into the corresponding document (OTP, MTP, PND) by clicking on the ReBuild All button.

---

**Note:** This function is available for OTP and flash type MCUs
The HT-IDE3000 software version must be 7.71 or above
The Hope3000 software version must be 3.06 or above

---

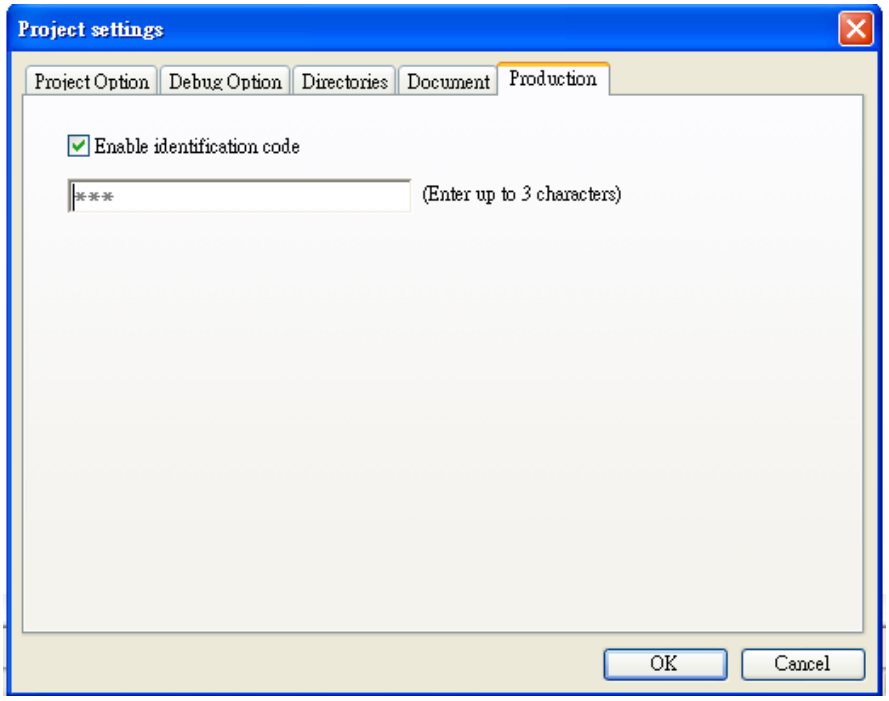
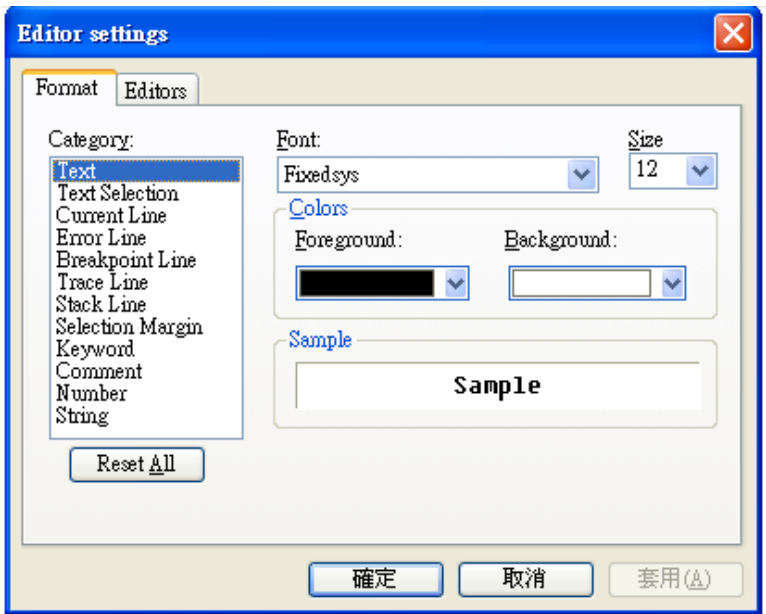



Fig 3-26

## Editor Settings

→ **Format**

This command is used to set the foreground and background colours.From the available options, shown in Fig 3-27, Text Selection is used for the Edit menu, Current line, Breakpoint Line, Trace Line and Stack Line are for the Debug menu and Error line is for



the Assembler output.

Fig 3-27

→ **Editors**

This command is used to set the editor options such as tab size, the Undo command count and some functions' disable settings. The Save Before Assemble option will save the file before assembly. The automatic reload of extemally modified files will load the files automatically which have been modified externally. The Disable Classview option will not display any information on the classview window. The Disable Suggestions list is disable variable tip list. The Disable Suggestions Tip is used to disable the function parameters tip.

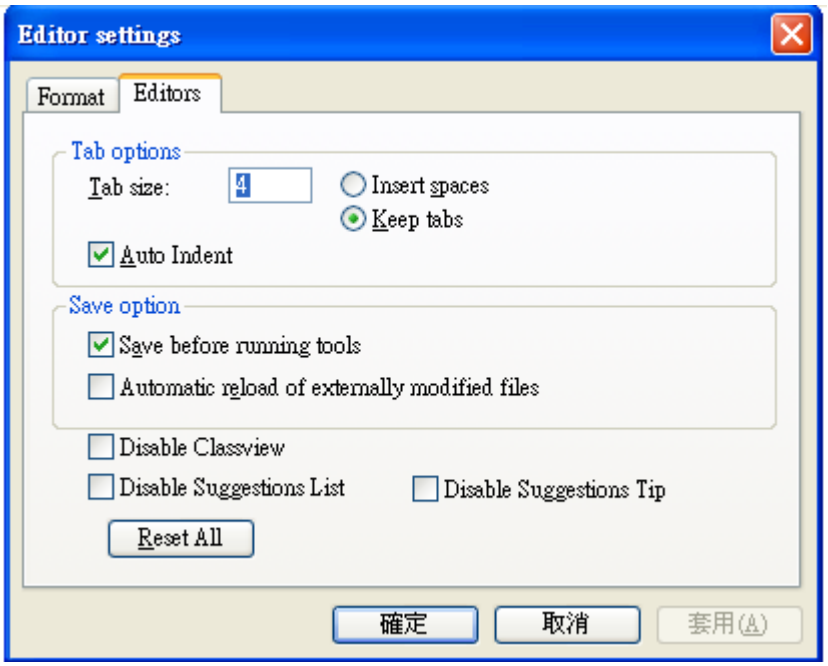



Fig 3-28

## Language

This command changes the language of the user interface. 'Default' is the language of the operation system.

## Customise

This command can rearrange and modify the toolbar buttons, menu and menu commands. Users can customise the toolbars according to their own preferences.

## e-Link Activation

The e-link must be registered when first used. Click on the About HT-IDE3000 options in the Help menu and a dialog box will be displayed as shown:

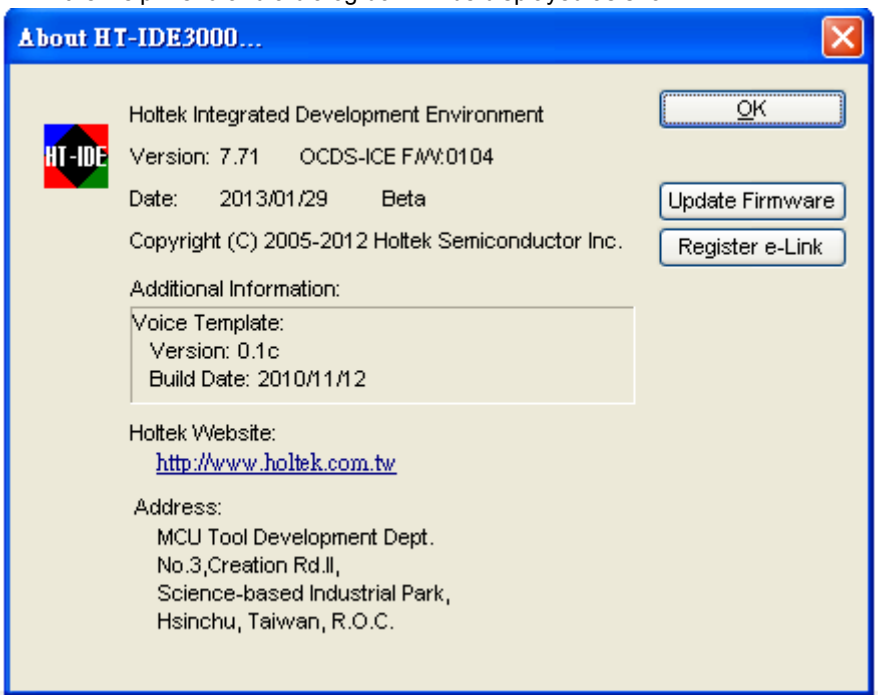



Fig 3-29

Click on the Register e-Link button and a dialog box will be displayed as follows:

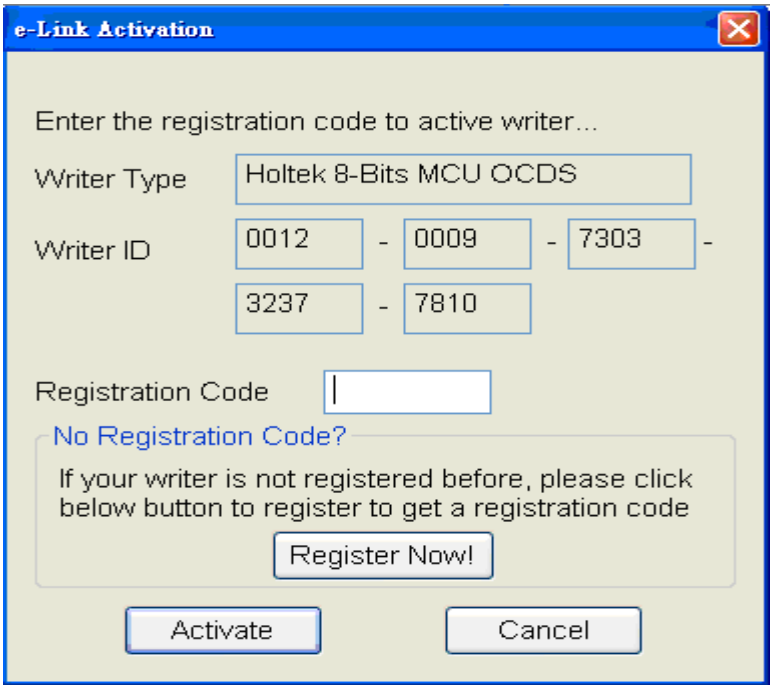

e-Link Activation
Enter the registration code to active writer...
Writer Type
Holtek 8-Bits MCU OCDS
Writer ID
0012 - 0009 - 7303 -
3237 - 7810
Registration Code
No Registration Code?
If your writer is not registered before, please click below button to register to get a registration code
Register Now!
Activate
Cancel

Fig 3-30

Click on the Register Now button, a dialog box will be displayed as follows:

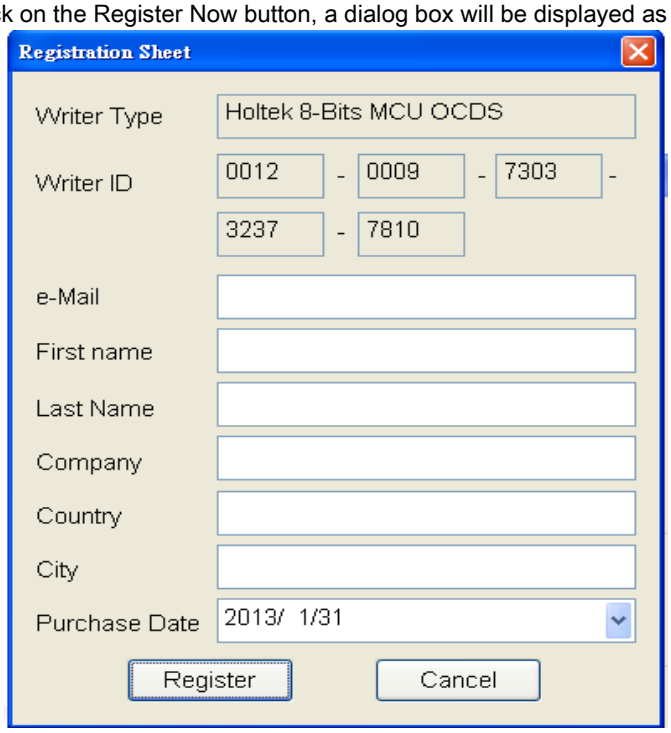



Fig 3-31

Fill out the register information. The e-Mail field is required, the others are optional fields. After filling out the fields, click on the Register button and you will receive an e-mail in your mailbox after a short time. The message header is e-Writer Pro Registry Key. Fill in the Registration Code field and click on the Active button. The following message will be displayed which represent a successful register process.

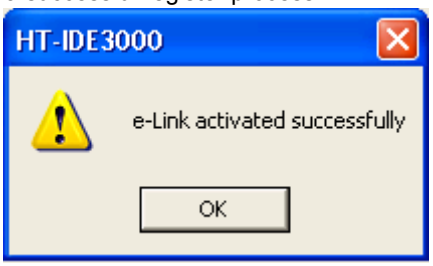



Fig 3-32

# Bookmarks

The Bookmark window is a useful companion tool for the Code Editor. Lines in the user code can be marked with bookmarks. This enables the user to open files and navigate directly to the lines marked simply by double- clicking entries in the Bookmark window.

## Bookmarks Window

The Bookmark window can be selected from the Window menu

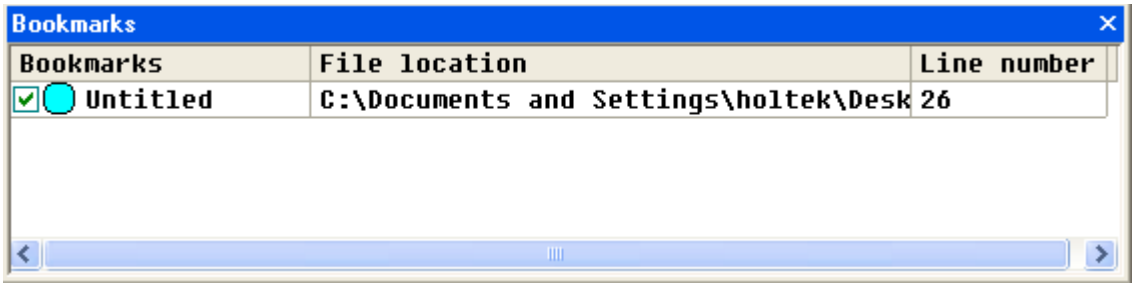



Fig3-33

Bookmarks

Displays the name of the bookmark. Default names are created as Untitled. Custom bookmark names can be created by double-clicking on the bookmark name entry.

Each bookmark has its own check box. To activate an existing bookmark, select its check box in the Bookmarks window. To hide, but not remove, an existing bookmark, clear its check box in the Bookmarks window.

File Location

Lists the fully qualified path for the file.

Line Number

Lists the line code numbers where the bookmarks are located.

Tip: Double clicking on the file location or line number will open the file and navigate directly to the marked lines.

## Bookmark Window Toolbar

Fig3-34

Toolbars from left to right are:

Toggle a bookmark on the current line

Adds or removes a bookmark on the selected line of the document in the active Editor. Does not alter the code line bookmarked.

Move the indicator to the previous bookmark

Selects the previous enabled bookmark in the Bookmark window. When the first bookmark is reached, it jumps ahead to the last one. As required, it opens the file where the selected bookmark occurs in the Editor. Scrolls that document to the bookmarked line and places the insertion point there.

Move the indicator to the next bookmark

Selects the next bookmark that is enabled in the Bookmark window. When the last bookmark is reached, it jumps back to the first one. As required, it opens the file where the selected bookmark occurs in the Editor. Scrolls that document to the bookmarked line, and places the insertion point there.

Move the indicator to the previous bookmark in the current file

Selects the previous bookmark that is enabled within the current file in the Bookmark window. When the first bookmark is reached, it jumps ahead to the last one in the current file. As required, it opens the file where the selected bookmark occurs in the Editor. Scrolls that document to the bookmarked line, and places the insertion point there.

Move the indicator to the next bookmark in the current folder

Selects the next bookmark that is enabled within the current file in the Bookmark window. When the last bookmark is reached, it jumps back to the first one in the current file. As required, it opens the file where the selected bookmark occurs in the Editor. Scrolls that document to the bookmarked line, and places the insertion point there.

Clear all bookmarks

Clears all bookmarks in the Bookmarks window. Does not alter the bookmarked line code..

## Bookmark menu

In addition to using the Bookmarks in the Toolbar, the same operation can be executed using the Bookmarks Menu.

The menu can be found in the edit drop-down menu

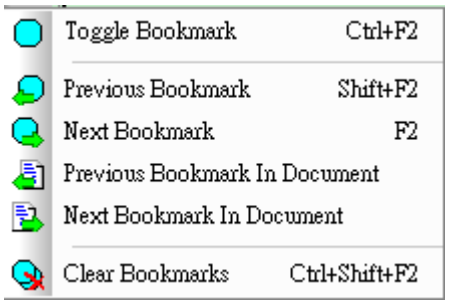

Toggle Bookmark Ctrl+F2
Previous Bookmark Shift+F2
Next Bookmark F2
Previous Bookmark In Document
Next Bookmark In Document
Clear Bookmarks Ctrl+Shift+F2

Fig 3-35

Chapter 4

# Menu - Project & Build

4

The HT-IDE3000 provides an example Project, which will assist first time users in quickly familiarizing themselves with project development. It should be noted that from the standpoint of the HT-IDE3000 system, a working unit is a project with each user application described by a unique project.

When developing an HT-IDE3000 application for the first time, the development steps, as described earlier, are recommended.

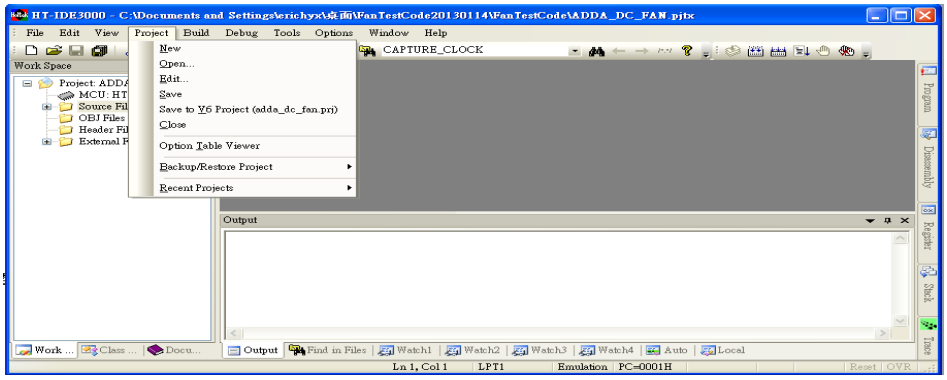



Fig 4-1

# Create a New Project

In the Project menu (Fig 4-1), select the New command to create a new project. This command will call the CodeWizard to assist users to create a new project.

**Note:** The project name is a file name with the extension .PJT and .PJTX.

## CodeWizard flowchart

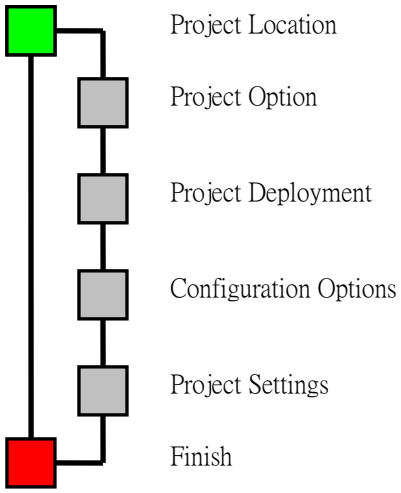



Fig 4-2

## Step1: Project Location

This step will require the user to input a project name and a file path – see Fig 4-3. Users can access all of the data and already existing projects to select an already existing project, or can instead input a new project name. Additionally, users can select the required microcontroller for their project and the lauguage tools. For some certain MCUs, a BootLoader option is available and this option provides an IAP function - see Fig 4-4.

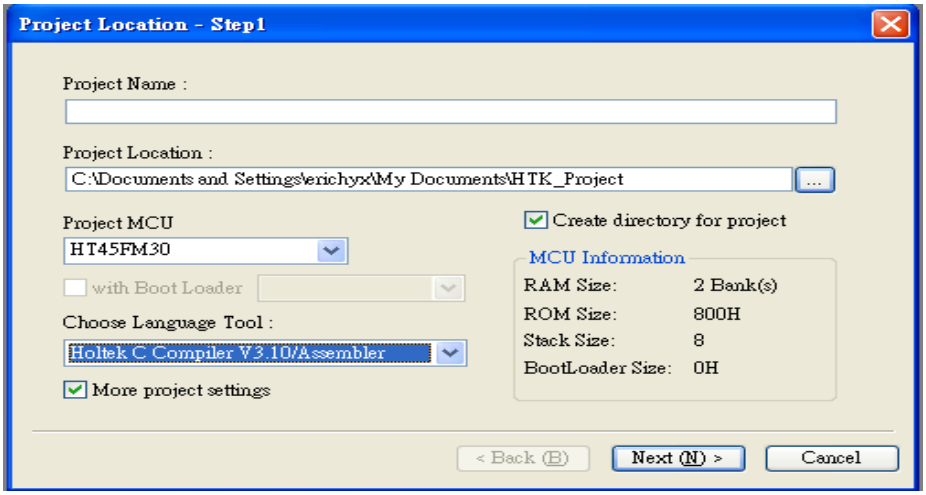



Fig 4-3

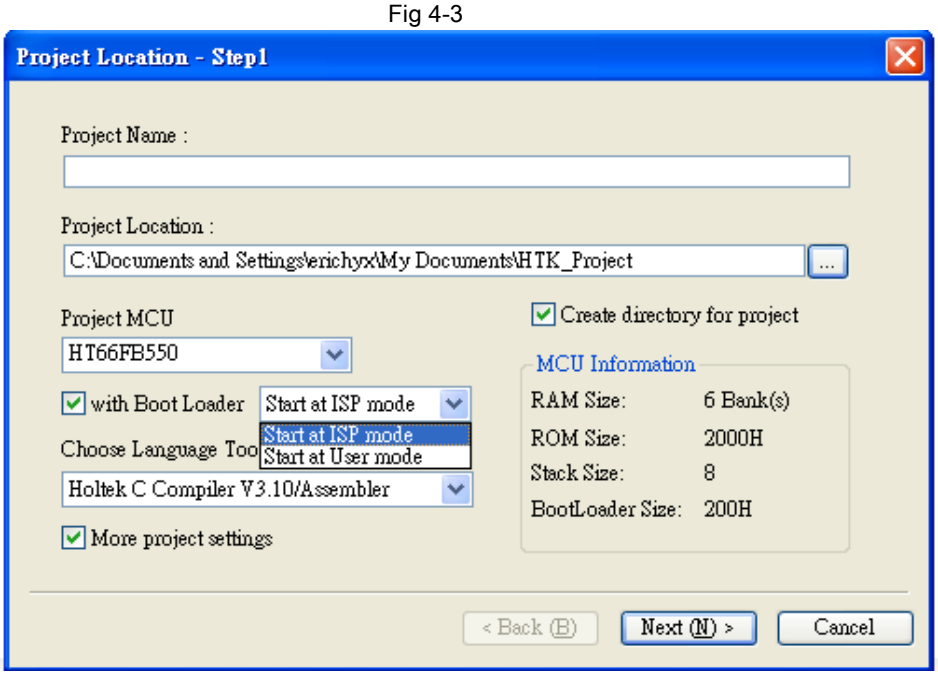



Fig 4-4

## Step2: Project Option

The second step is to select whether assembly files or C-language files are to be used in the project.

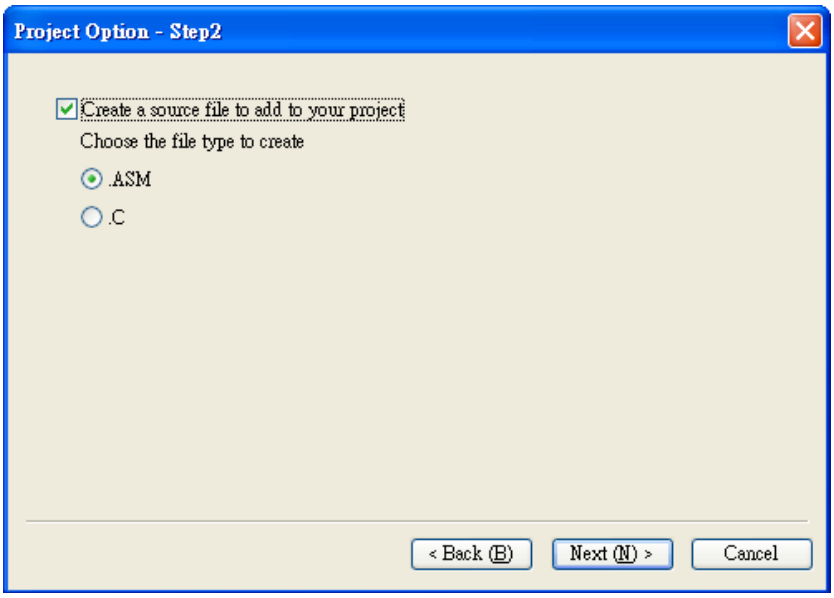



Fig 4-5

## Step3: Project Deployment

This step is to change the source program File name, program section and data section.

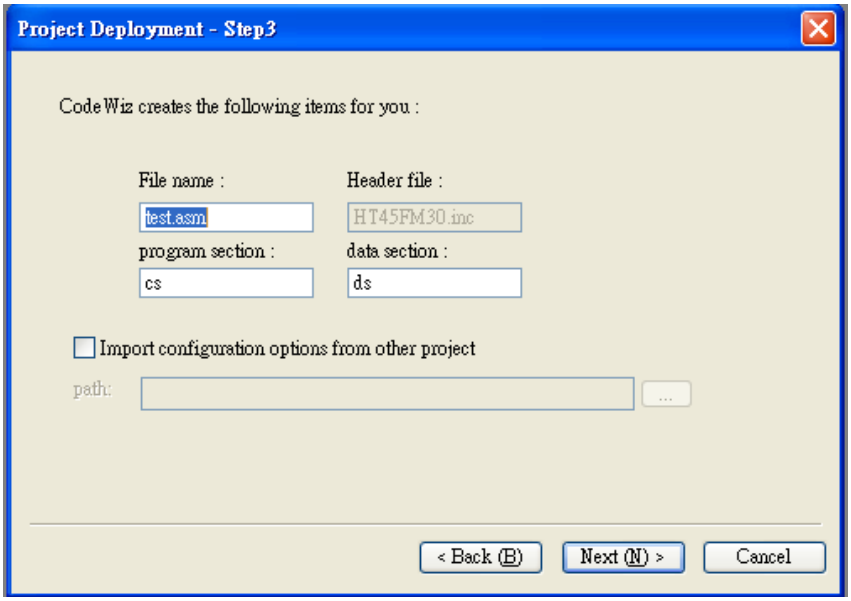



Fig 4-6

And finally is the Configuration Option and Project Setting operations. For this consult the related chapters.

## Open and Close a Project

The HT-IDE3000 can work with only one project at a time, which is the opening project, at any time. If a project is to be worked upon, the project should first be opened, by using the Open command of the Project menu (Fig 4-1). Then, insert the project name directly or browse the directories and select a project name. Use the Close command to close the project.

---

**Note:** When opening a project, the current project is closed automatically. Within the development period, i.e. during editing, setting options and debugging etc., ensure that the project is in the open state. This is shown by the displaying of the project name of the opening project on the title of the HT-IDE3000 window. Otherwise, the results are unpredictable. The HT-IDE3000 will retain the opening project information if the system exits from the HT-IDE3000 without closing the opening project. This project will be opened automatically the next time the HT-IDE3000 is run.

---

## Manage the Source Files of a Project

Use the Edit command to add or remove source program files from the opened project. The order, from top to bottom, of each source file in the list box, is the order of the input files to the Cross Linker. The Cross Linker processes the input files according to the order of these files in the box. Two buttons, namely [Move Up] and [Move Down], can be used to adjust the order of a source file in the project. Fig 4-7 is the dialog box of the Project menu's Edit command.

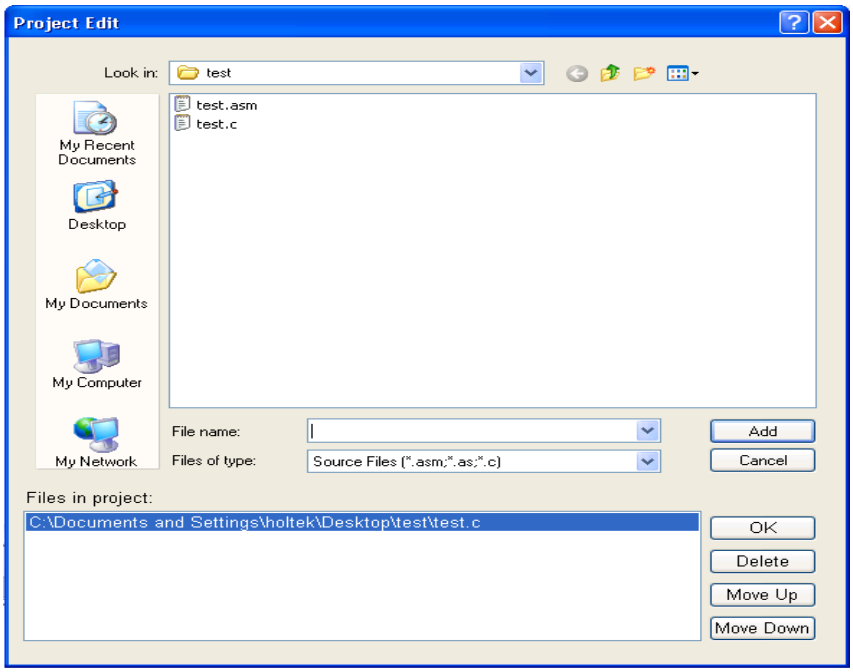



Fig 4-7

## To Add a Source File to the Project

Choose a source file name from the file list box. Double-click the selected file name or choose the Add button to add the source files to the project. When the selected source file has been added, This file name is displayed on the list box of the Files in project.

## To Delete a Source File from the Project

- Choose the file to be deleted from the project
- Click the Delete button

**Note:** Deleting the source files from the project does not actually delete the file but refers to the removal of the file information from the project.

## To Move a Source File Up or Down

- Choose the file to be moved in the list box (Files in project), by moving the cursor to this file and clicking the mouse button
- Click the [Move Up] button or the [Move Down] button

# Build a Project's Task Files

Be sure that the following tasks have been completed before building a new project:

- The project has been opened
- The project options have all been set
- The project source files have been added
- The MCU options have been set (refer to the Tools menu chapter)

There are two commands related to the building of a project file, the Build command and the Rebuild all command.

The Project menu's Build command performs the following operations:

- Assemble or compile all the source files of the current project, by calling the Cross Assembler or C compiler depends on the file extension .asm or .C
- Link all the object files generated by the Cross Assembler or C compiler, and generate a task file and a debugging file.
- Load the task file into the ICE if it is powered-on
- Display the source program of the execution entry point on the active window (the HT-IDE3000 refers to the source files, the task file and the debugging file for emulation)

---

**Note:** The Build command may or may not execute the above tasks as the execution is dependent on the creation date/time of all corresponding files. The rules are:

- If the creation date/time of a source file is later than that of its object file, then the Cross Assembler or C compiler is called to assemble, compile this source file and to generate a new object file.
- If one of the tasks object files has a later creation date/time than that of the task file, then the Cross Linker is called to link all object files of this task and to generate a new task file.

---

The Build command downloads the task file into the ICE automatically whether there is an action or not.

The Rebuild All command carries out the same task as the Build command. The difference is that the Rebuild All command will execute the task immediately without first checking the creation date/time of the project files.

The result message of executing a Build or Rebuild All command are displayed on the

Output window. If an error occurs in the processing procedure, the actions following it are skipped, and no task file is generated, and no download is performed.

### To Build a Project Task File

- Click the Open command of the Project menu to open the project
- Click either the Build command of the Build menu or the Build button on the toolbar (Fig 4-1) to start building a project

### To Rebuild a Project Task File

- Click the Open command of the Project menu to open the project
- Click either the Rebuild All command of the Project menu or the Rebuild all button

on the toolbar (Fig 4-1) to start building a project once the project task has been built successfully, emulation and debugging of the application program can begin (refer to the HT-IDE3000 menu - Debug chapter).

## Assemble/Compile

To verify the integrity of application programs, this command can be used to assemble or compile the source code and display the result message in the Output window.

### To Assemble or Compile a Program

- Use the File menu to open the source program file to be assembled or compiled
- Either select the Assemble/Compile command of the Build menu or click the Assemble button on the toolbar to assemble/compile this program file

If the opened file has an .asm file extension name, the Cross Assembler will execute the assembly process. If the file has a .C extension then the C compiler will compile the program.

If no errors are detected, an object file with extension .OBJ is generated and stored in the directory which is specified in the Output Files Path (refer to Options menu, Directories command). If an error occurs and a corresponding message displayed on the Output window, one of the following commands can be used to move the cursor to the error line:

- Double-click the left button of the mouse or
- Select the error message line on the Output window, and press the <Enter> key

# Print Option Table Command

This command is used to view and check the files (otp, mtp, pnd, cod) in the project (Fig 4-8). The Browse button is used to open the files. The Print button is used to print the current active option file to the specified printer. The printer may be selected when the option file is to be printed out. It is recommended to use a different printer port from the port which is connected to the ICE.

If both the printer and the ICE are using the same printer port, issuing this command will cause the loss of all debug information and corresponding data. After the printing job has finished, the user should proceed to the very beginning of the development procedure and use the Build command of the Project menu if further emulation/debugging of the application program is required.

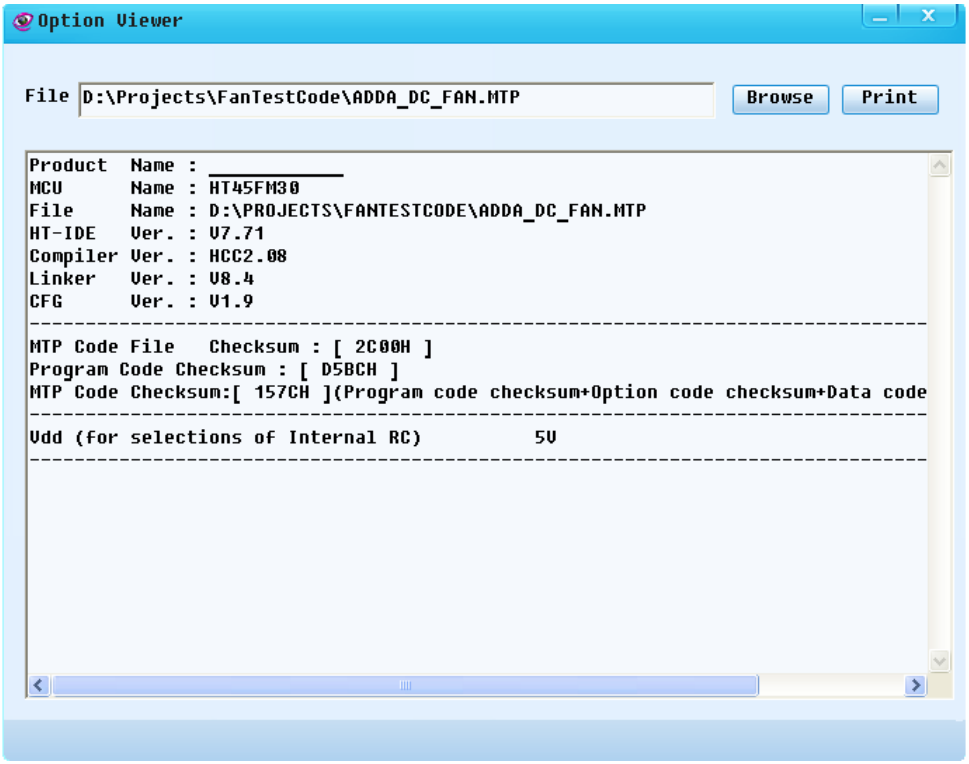

Option Viewer
File
D:\Projects\FanTestCode\ADDA_DC_FAN.MTP
Browse
Print
Product Name : _____
MCU Name : HT45FM30
File Name : D:\PROJECTS\FANTESTCODE\ADDA_DC_FAN.MTP
HT-IDE Ver. : V7.71
Compiler Ver. : HCC2.08
Linker Ver. : V8.4
CFG Ver. : V1.9
MTP Code File Checksum : [ 2C00H ]
Program Code Checksum : [ D5BCH ]
MTP Code Checksum:[ 157CH ](Program code checksum+Option code checksum+Data code
Vdd (For selections of Internal RC) 5V

Fig 4-8

# Backup/Restore Project

The Backup Project command will use PROJECT_DATE_VERSION format to compress the current project, and also allow users to add some project description in [Description] editing box if necessary.

The Restroe Project command will restore the compressed project which selected in the backup list box currently.

Chapter5

# Menu - Debug

5

In the development process, the repeated modification and testing of source programs is an inevitable procedure. The HT-IDE3000 provides many tools not only to facilitate the debugging work, but also to reduce the development time. Included are functions such as single stepping, symbolic breakpoints, automatic single stepping, trace trigger conditions, etc.

After the application program has been successfully constructed, (refer to the chapter on Build a project's task files) the first execution line of the source program is displayed and highlighted in the active window (Fig 5-1). The HT-IDE3000 is now ready to accept and execute the debug commands.

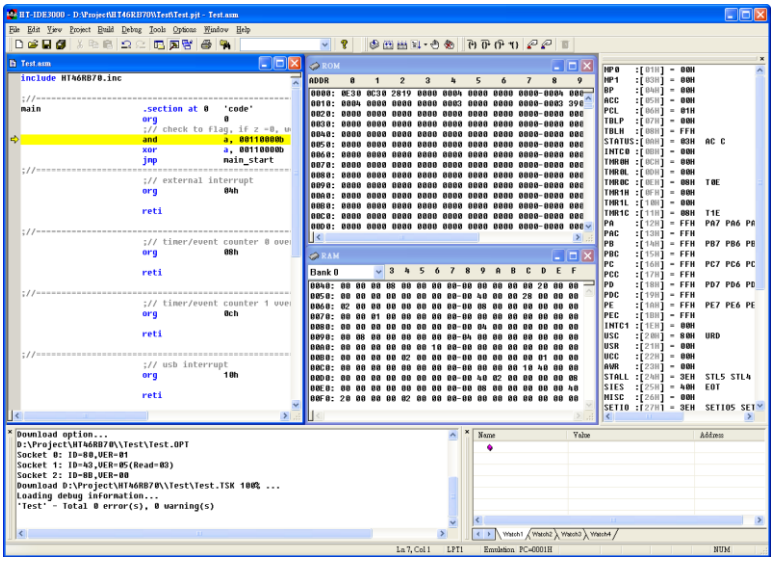


Fig 5-1

# Reset the HT-IDE3000 System

There are 4 kinds of reset methods in the HT-IDE3000 system:

- Power-on reset (POR) by plugging in the power adapter or pressing the reset button on the ICE
- Reset from the target board
- Software reset command in the HT-IDE3000 Debug menu (Fig 5-2)
- Software power-on reset command in the HT-IDE3000 Debug menu (Fig 5-2)

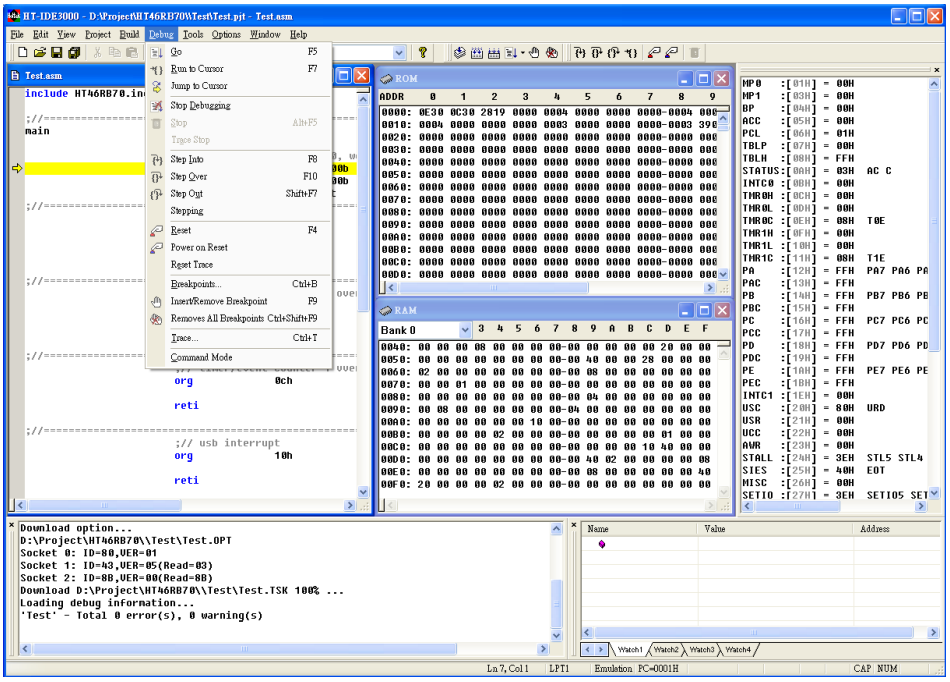
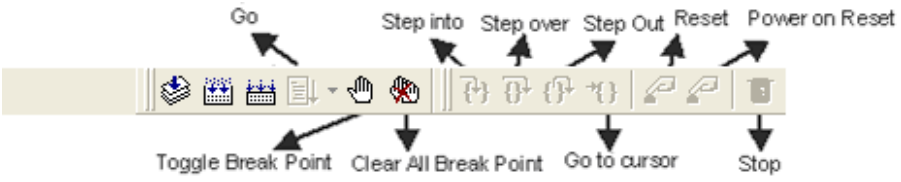



Fig 5-2



The effects of the above 4 types of reset are listed in table 5-1.

| Reset Item | Power-On Reset | Target Board Reset | Software Reset Command | Software Power-On Reset Command |
|---|---|---|---|---|
| Clear Registers | (*) | (*) | (*) | (*) |
| Clear Options | Yes | No | No | No |
| Clear PD，TO | Yes | No | No | Yes |
| PC Value | (**) | 0 | 0 | 0 |
| Emulation Stop | (**) | No(***) | Yes | Yes |
| Check Stand-Alone | Yes | No | No | No |

Table 5-1

**Note:** (*) : Refer to the Data Book of the corresponding MCU for the effects of registers under the different resets.

(**) ： The PC value is 0 and the emulation stops.

(***) : If the reset is from the target board, the MCU will start emulating the application after the reset is completed.

PC - Program Counter

PDF - Power Down Flag

TO - Time-out Flag

### To Reset from the HT-IDE3000 Commands

- Either choose the Reset command from Debug menu or click the Reset button on the toolbar to execute a software reset
- Either choose the Power-on Reset command from the Debug menu or click the Power-on Reset button to execute a software power on reset

## Emulation of Application Programs

After the application program has been successfully written, the Build or Rebuild command should be executed to build the project files and download the programs to the hardware simulator. If successful, the first executable line of the source program will be displayed and highlighted on the active window (Fig 5-1). At this point, emulation of the

application program can begin by using the HT-IDE3000 debug commands.

**Note:** During emulation of an application program, the corresponding project has to be open.

### To Emulate the Application Program

- Choose the Go command from the Debug menu
  or press the hot key F5
  or press the Go button on the toolbar

Other windows can be activated during emulation. The HT-IDE3000 system will automatically stop the emulation if a break condition is met. Otherwise, it will continue emulating until the end of the application program. The Stop button on the toolbar is illuminated with a red color while the ICE is in emulation. Pressing this button will stop the emulation process.

### To Stop Emulating the Application Program

There are three methods to stop the emulation, shown as follows:

- Set the breakpoints before starting the emulation
- Choose the Stop command of the Debug menu or press the hot key Alt+F5
- Press the Stop button on the toolbar

### To Run the Application Program to a Line

The emulation may be stopped at a specified line when debugging a program. The following methods provide this function. All instructions between the current point and the specified line will be executed except the conditional skips. Note however that the program may not stop at the specified line due to conditional jumps or other situations.

- Move the cursor to the stopped line (or highlight this line)
- Choose the Go to Cursor command of the Debug menu
  or press the hot key F7
  or press the Go to Cursor button on the toolbar

### To Directly Jump to a Line of an Application Program

It is possible to jump directly to a line, if the result of executed instructions between the current point and the specified line are not important. This command will not change the contents of Data Memory, registers and status except for the Program Counter. The specified line is the next line to be executed.

- Move the cursor to the appropriate line or highlight this line
- Choose Jump to Cursor command of the Debug menu

## Single Step

The execution results of some instructions in the above section may be viewed and checked. It is also possible to view the execution results one instruction at a time, i.e., in a step-by-step manner. The HT-IDE3000 provides two step modes, namely manual mode and automatic mode.

In the manual mode, the HT-IDE3000 executes exactly one step command each time the single- step command is executed. In the automatic mode, the HT-IDE3000 executes single step commands continuously until the emulation stop command is issued, using the Stop command of the Debug menu. In the automatic mode, all user specified breakpoints are discarded and the step rate can be set from FAST, 0.5, 1, 2, 3, 4 to 5 seconds. There are 3 step commands, namely Step Into, Step Over and Step Out.

- The Step Into command executes exactly one instruction at a time, however, it will enter the procedure and stop at the first instruction of the procedure when it encounters a CALL procedure instruction.
- The Step Over command executes exactly one instruction at a time, however upon encountering a CALL procedure, will stop at the next instruction after the CALL instruction instead of entering the procedure. All instructions of this procedure will have been executed and the register contents and status may have changed.
- The Step Out command is only used when inside a procedure. It executes all instructions between the current point and the RET instruction (including RET), and stops at the next instruction after the CALL instruction.
- To start Step Into
  Choose the Step Into command from the Debug menu
  or press the hot key F8
  or press the Step Into button on the toolbar
- To start Step Over
  Choose the Step Over command of the Debug menu
  or press the hot key F10
  or press the Step Over button on the toolbar

- To start Step Out
  Choose the Step Out command of the Debug menu
  or press the hot key Shift+F7
  or press the Step Out button on the toolbar

---

**Note:** The Step Out command should only be used when the current pointer is within a procedure or otherwise unpredictable results may happen.

---

If entering the automatic mode, first choosing the Debug option attribute page of the Project Settings from the Options menu to set the two step commands, Step Into or Step Over in the automatic mode.

- To start automatic single step mode
  Choose the Stepping command from the Debug menu also choose the stepping speed (the step command is set in the Debug command from the Options menu)
- To end automatic single step mode
  Choose the Stop command from the Debug menu
- To change automatic single step command for the automatic mode
  - Choose the Project Settings command from the Options menu
  - Choose the Step Into or the Step Over command in the Debug option attribute page of the Project Settings dialog box

# Breakpoints

The HT-IDE3000 provides a powerful breakpoint mechanism which accepts various forms of conditioning including program address, source line number and symbolic breakpoint, etc

## Breakpoint Features

The following are the main features of the HT-IDE3000 breakpoint mechanism:

- Any breakpoint will be recorded in the breakpoints list box after it is set, however this breakpoint may not be immediately effective. It can be set to be effective later, as long as it is not deleted, i.e.still in the breakpoints list box.
- Breakpoints of address or data, in binary form with don’t-care bits, are permitted.

- When an instruction is set to be an effective breakpoint, the ICE will stop at this instruction, but will not execute it, i.e. this instruction will become the next one to be executed. Although an instruction is an effective breakpoint, the ICE may not stop at this instruction due to execution flow or conditional skips. If an effective breakpoint is in the Data Space (RAM), the instruction that matches this conditional breakpoint data will always be executed. The ICE will stop at the next instruction.

**Note:** 1. The ICE can only have a maximum of 3 breakpoints active at the same time, while e-ICE can enjoy up to 65536 effective breakpoints.

2. It is acceptable to set breakpoints in Free Run mode for ICE, however, e-ICE is not.

## Description of Breakpoint Items

A breakpoint consists of the following descriptive items. It is not necessary to set all items,

Fig 5-3:

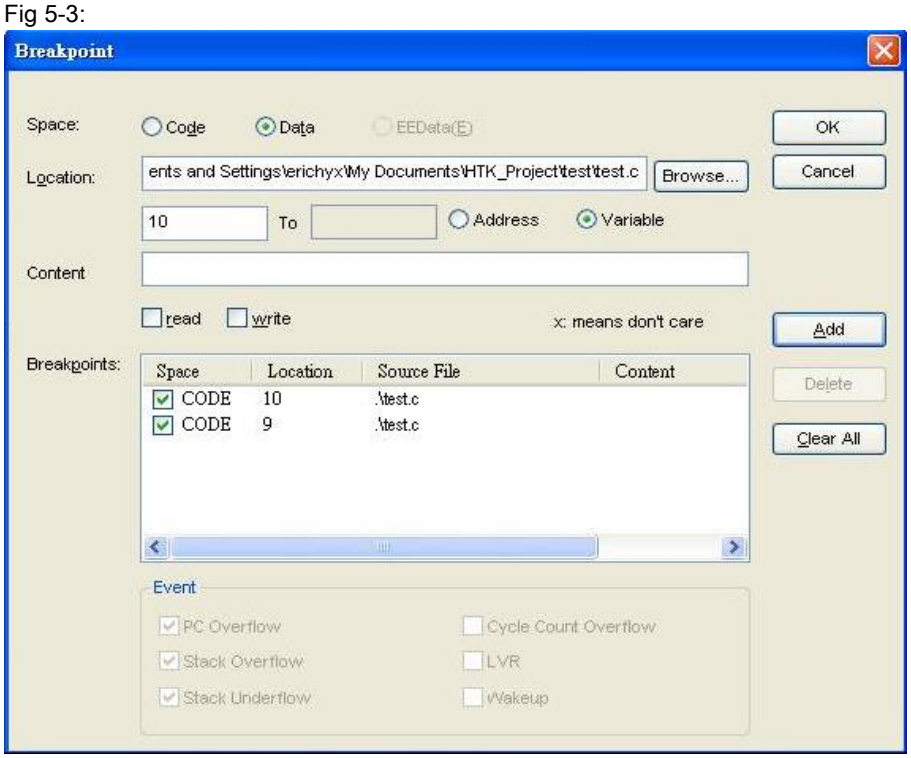



Fig 5-3

- Space

The location of the breakpoints, can be set in Program Code space, Data space or EEData space.

- Location

  For the actual location of the breakpoint, there are two different methods to comfirm the location: Address and Line number.

  Line number method:

  – Input the file name which the location of the breakpoint belongs to. This file can be either a.C or .ASM file. If there is no file name, then the current file will be taken as a default.

  – Input the line number of the breakpoint:

    For the ICE and e-ICE, multiple line settings are not allowed. They can only be set one line at a time. Therefore only the first edit box is active and there is no need to input the second edit box. For the e-Link, if setting one line, then the second edit box does not need to be filled out. If setting multiple lines, the first line number and the last line number should be written in the two edit boxes respectively.

  – In addition to the line number, the symbol name is also allowed to input to the first edit box.

    When it is Code Space, the allowed symbols are as follows:

    Label name. If programming in C language, the label name is a name in the .ASM file.

    Section name

    Procedure name, which is the function name. If programming in C language, the procedure name is the name in the .ASM file.

    When it is Data Space, the allowed symbols are as follows:

    Dynamic data symbols defined in data section. If programming in C language, the name is a name in the .ASM file and must be a global variable.

    Address method:

  – In this mode, only the address is needed.

  – When it is Code Space, this address is an address in Program.

  – When it is Data Space, this address is an address in RAM.

  – When it is EEData Space, this address is EEPROM address.

- Content

  The data content of the breakpoint. This item is effective only when the Space is assigned to the Data space. The Read and Write check box are used for the executing conditions of the breakpoint.

- Breakpoints

  The Breakpoints list box contains all the breakpoints that have been added, including the effective breakpoints and non-effective breakpoints. The Add button should be used to add new breakpoints to the list box and the Delete button is to remove breakpoints from the list box.

- Event

  Only the e-Link supports events. When the checked events occur, the e-Link will stop.

**Note:** The breakpoint in data space is only available for ICE but e-ICE.

→ **Format of Description Items – Location**

The allowed formats of Location items are:

- Absolute address (in code space or data space) with 4 format types, namely decimal, hexadecimal (suffix with “H” or “h” or prefix with 0x), binary and don’t-care bits. For example

  **20, 14h , 0x14, 00010100b , 10xx0011**

  represents decimal 20, hexadecimal 14h/0x14, binary 00010100b and don't-care bits 4 and 5 respectively.

**Note:** Don’t-care bits must be in binary format.

→ **Format of Description Items – Content**

The content format has five digital number options, similar to the format of Location. These four types of number are decimal, hexadecimal (suffix with “H” or “h”), binary and don’t-care bits.

## How to Set Breakpoints

There are four methods to set/enable a breakpoint, one is by using the Breakpoint command from the Debug menu, the others are by using the Toggle Breakpoint button on the toolbar, double clicking on the gray bar in the edit window, or pressing key F9. The rules of the breakpoint mechanism are as follows:

- If the breakpoint to be set is not in the Breakpoints list box (Fig 5-3), then the descriptive items must be designated first, then added to the Breakpoints list box.

- As long as the breakpoint exists in the list box, it can be made effective by Enabling the breakpoint if it fails to be initially effective.
- Press the OK button for confirmation. Otherwise, all changes here will not be effective.
- When using the Toggle Breakpoint button on the toolbar, the cursor should first be moved to the breakpoint line, and then the Toggle Breakpoint button pressed. If an effective breakpoint is to be changed to a non-effective breakpoint, this can be achieved by merely pressing the Toggle breakpoint button.

→ **To Add a Breakpoint**

- Choose the Breakpoint command from the Debug menu (or press the hot key Ctrl+B)
  A breakpoint dialog box is displayed (Fig 5-3)
- Designate the descriptive items of the breakpoint
  Set Space, Location items
  Set Content item and Read/Write check box if Space is the data space
- Press the Add button to add this breakpoint to the Breakpoints list box.
- Press the OK button to confirm

---

**Note:** If the total count of the effective breakpoints is less than 3, the newly added one will take effect automatically after it has been added.

---

→ **To Delete a Breakpoint**

- Choose the Breakpoint command from the Debug menu or press the hot key Ctrl+B
  A breakpoint dialog box is displayed (Fig 5-3)
- Choose or highlight the breakpoint to be deleted from the Breakpoints list box
- Press the Delete button to delete this breakpoint from the Breakpoints list box
- Press the OK button to confirm

→ **To Delete all Breakpoints**

- Choose the Breakpoint command from the Debug menu or press the hot key Ctrl+B
  A breakpoint dialog box is displayed (Fig 5-3)
- Choose the Clear All button to delete all breakpoints from the Breakpoints list box
- Press the OK button to confirm
- You can also click the Clear All Breakpoint button on the toolbar to accomplish this

task.

→ **To Enable (Disable) a Breakpoint**

- Choose the Breakpoint command from the Debug menu or press the hot key Ctrl+B
  A breakpoint dialog box is displayed (Fig 5-3)
- Choose the disabled (enabled) breakpoint from the Breakpoints list box
- Press the Enable (Disable) button, to enable or disable this breakpoint
- Press the OK button to confirm

# Trace the Application Program

The HT-IDE3000 provides a powerful trace mechanism which records the execution processes and all relative information when the HT-IDE3000 is emulating the application program. The trace mechanism provides qualifiers to filter specified instructions and trigger conditions in order to stop the trace recording. It also provides a method to record a specified count of the trace records before or after a trigger point.

**Note:** When the HT-IDE3000 starts emulating (refer to the section on Emulation of the Application Programs), the trace mechanism will begin to record the executing instructions and relative information automatically, but not vice versa.

**Note:** Only the ICE supports the trace mechanism function. The e-ICE and OCDS do not support this function.

## Initiating the Trace Mechanism

The basic requirement for initializing the trace mechanism is to set the Trace Mode with or without Qualify. The Trace Mode defines the trace scope of the application program and Qualify defines the filter conditions of the trace recording.

The available Trace Modes are:

- Normal
  Sets the trace scope to all application programs and is the default mode.
- Trace Main

Sets the trace scope to all application programs except the interrupt service routine programs.

- Trace INT

  Sets the trace scope to all interrupt service routine programs.

According to Qualify, the trace mechanism decides which instructions and what corresponding information should be recorded in the trace buffer during the emulation process. The rule is that an instruction will be recorded if its information and status satisfy one of the enabled qualifiers. If all the program steps are required to be recorded, then No Qualify is needed (do not set the Qualify). The default is No Qualify.

Qualify format

- **[source_file_name!].line_number**

– where the source_file_name is a name of the optional source file. If there is no file name, the current active file is assumed. The exclamation point "!" is necessary only when a source file name is specified. The dot . must prefix the line number which is decimal.

– For example:

C:\HIDE\USER\GE.ASM!.42

– Only the code executed at the 42nd line of the file GE.ASM is recorded.

– For example:

.48

– Only the code executed at the 48nd line of the current active file is recorded.

- **[source_file_name!].symbol_name**

– All are the same as the line number location format except that the line_number is replaced with symbol_name. The following program symbols are acceptable:

– Label name

– Section name

– Procedure name

– Dynamic data symbols defined in data section

In contrast to the Trace Mode and Qualify, which specify the conditions of trace recording, both the Trigger Mode and Forward Rate specify the conditions to stop the trace recording.

The Trigger Mode specifies the kind of the stop trace trigger point, and is a standard used

to determine the location of the stop trace point. The Forward Rate specifies the trace scope between the trigger point and the stop trace point.

The available Trigger Modes are:

- No Trigger
  No stopping of the trace recording condition. This is the default case.
- Trigger at Condition A
  The trigger point is at condition A.
- Trigger at Condition B
  The trigger point is at condition B.
- Trigger at Condition A or B
  The trigger point is at either condition A or condition B.
- Trigger at Condition B after A
  The trigger point is at condition B after condition A has occurred.
- Trigger when meeting condition A for k times
  The trigger point is when condition A has occurred k times.
- Trigger at Condition B after meeting A for k times
  The trigger point is at condition B after condition A has occurred for k times.

Condition A and Condition B specify the trigger conditions. The format of condition A or B is the same as that of the Qualify.

The Loop Count specifies the number of occurrences of the specified condition A. It is used only when the Trigger Mode is from one of the last two modes in the above list.

The Forward Rate specifies the approximate rate of the trace recording information between the trigger point and stop trace point in the whole trace buffer. The trigger point divides the trace buffer into two parts, before and after trigger point. The forward rate is used to limit the trace recording scope after the trigger point. The percentage is adjustable between 0 and 100%.

---

**Note:** It is not necessary for the trace recording scope to be equal to the forward rate. If a breakpoint is met before reaching the trace recording scope or a trace stop command (refer to: Stopping the trace mechanism) is issued, the trace recording will be stopped.

---

A Qualify list box records and displays all qualifiers used by the Trace Mode. Up to 20 qualifiers can be added into the list box and and up to 6 qualifiers can be effective. A

Qualifier can be disabled or deleted from the list box. In the Qualify list box,

the format of the qualifier is

**<status> {<space and read/write>, <location>,**
**<data content>, <external signal>}**

where <status> is effective status. “+” is effective (enabled) and “–” is non-effective (disabled). <space and read/write> is the space type and operating mode. “C” is the code space, "D/R" is the data space with read, “D/W” is the data space with write, “D/RW” is the data space with read and write.

<location>, <data content> and <external signal> have the same data format as the input form respectively.

## Stopping the Trace Mechanism

There are 3 methods to stop the trace recording mechanism：

- Set the trigger point (Trigger Mode) and Forward Rate as shown above
- Set breakpoints to stop the the emulation and the trace recording.
- Issue a Trace Stop command from the Debug menu (Fig 5-2) to stop the trace recording.

Fig 5-4 lists all the requirements to use the trace mechanism. This is the result of the Trace command from the Debug menu.

## Trace Start/Stop Setup

→ **To Set the Trace Mode**

- Choose the Trace command from the Debug Menu
  A Trace dialog box is displayed as in Fig 5-4.
- Choose a trace mode from the Trace Mode pull-down list box
- Press the OK button

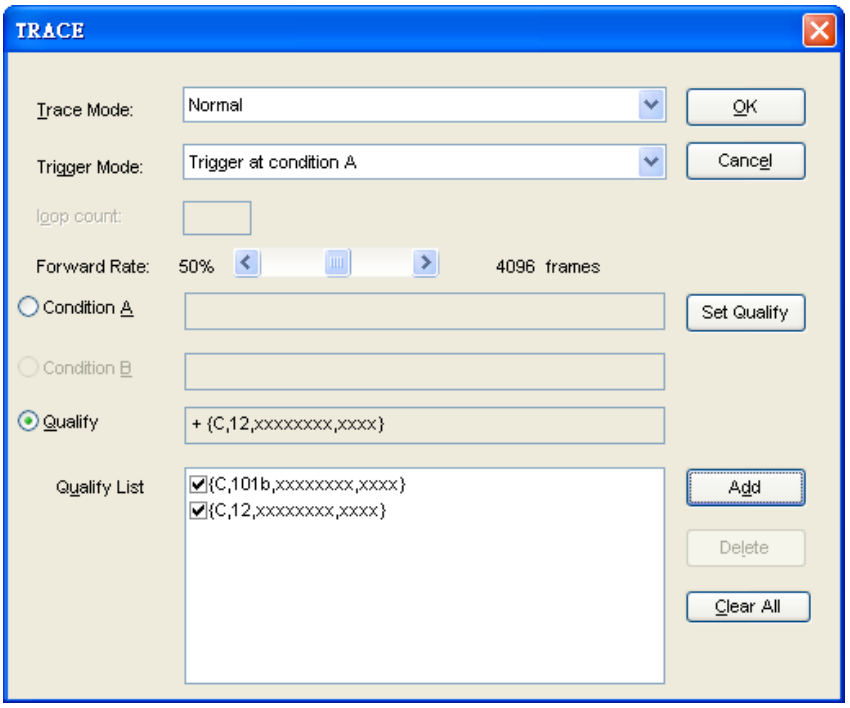



Fig 5-4

→ **To Set the Stop Trace Trigger Mode**

- Choose the Trace command from the Debug Menu

  A Trace dialog box is displayed as in Fig 5-4.
- Choose a trigger mode from the Trigger Mode pull-down list box
- press the OK button

→ **To Change the Forward Rate**

- Choose the Trace command from the Debug Menu

  A Trace dialog box is displayed as in Fig 5-4
- Use the Forward Rate scroll bar to specify the desired rate
- Press the OK button

→ **To Setup the Condition A/Condition B**

- Choose the Trace command of the Debug Menu

  A Trace dialog box is displayed as Fig 5-4.
- Press Condition A/Condition B radio button
- Press the Set Condition button

  A Set Qualify dialog box is displayed as in Fig 5-5.
- Enter the conditional information

- Press the OK button to close the Set Condition dialog box
- Press the OK button to close the Trace dialog box

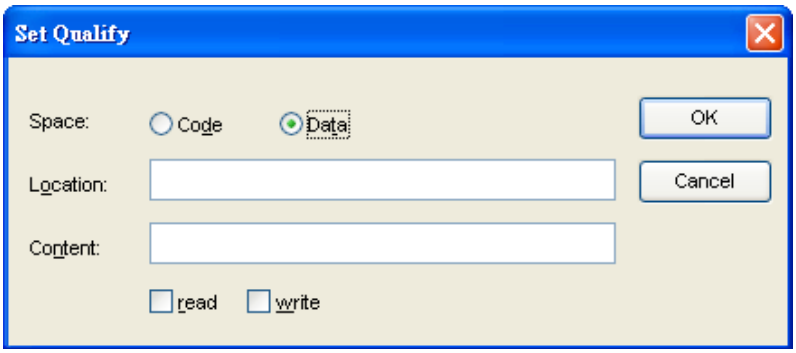



Fig 5-5

→ **To Add a Trace Qualify Condition**

- Choose the Trace command from the Debug Menu

  A Trace dialog box is displayed as in Fig 5-4.
- Press the Qualify radio button
- Press the Set Qualify button

  A Set Qualify dialog box is displayed as in Fig 5-5.
- Enter the qualifier information
- Press the OK button to close the Set Qualify dialog box
- Press the Add button to add the qualifiers into the Qualify list box below
- Press the OK button to close the Trace dialog box

→ **To Delete a Trace Qualify Condition**

- Choose the Trace command from the Debug Menu

  A Trace dialog box is displayed as in Fig 5-4.
- Choose the qualify line to be deleted from the Qualify list box
- Press the Delete button
- Press the OK button to confirm

→ **To Delete All Qualify Conditions**

- Choose the Trace command from the Debug Menu

  A Trace dialog box is displayed as in Fig 5-4.
- Press the Clear All button
- Press the OK button to confirm

**Note:** If there is no qualifier, all instructions are qualified by default.

→ **To Enable (Disable) a Trace Qualify Condition**

- Choose the Trace command from the Debug Menu
  A Trace dialog box is displayed as in Fig 5-4
- Choose the disabled (enabled) qualifier line to be enabled (disabled) from the Qualify list box
- Press the Enable (disable) button
- Press the OK button to confirm

---

**Note:** At most, 6 trace qualifications can be enabled at the same time. The e-ICE is limited to the Normal Mode, the trace range is for the whole application program.

---

## Trace Record Format

Once the trace qualify and trigger conditions have been setup, those instructions which satisfy the qualify conditions will be recorded in the trace buffer. The trace recorded fields may not all be displayed on the screen except for the sequence number and disassemble instructions. These fields are dependent upon the Trace Recoord Fields settings in the Debug option attribute page of Project Settings sub-menu from the Options menu. The text enclosed by the parentheses are the headings shown in the Trace List command of the Window menu. Fig 5-6 and Fig 5-7 illustrate the contents of the trace list under the different debug options.

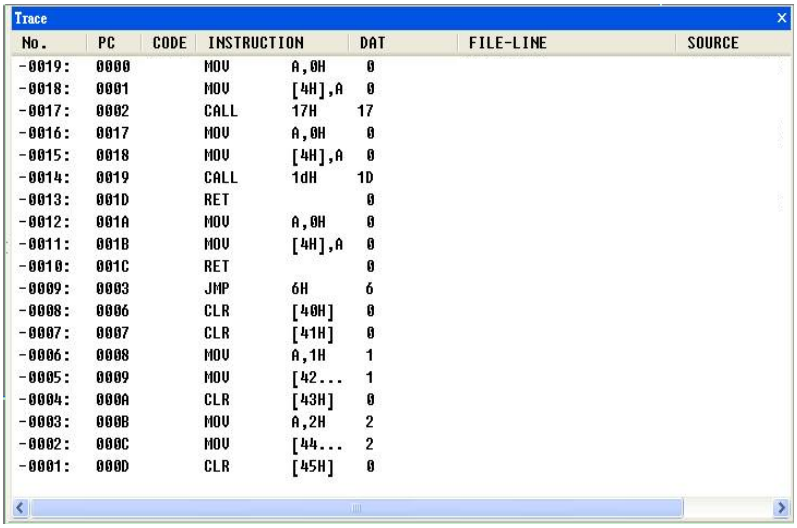



Fig 5-6

- Sequence number (No)
  For any of the trigger modes, the sequence number of a trigger point is +0. The trace

records before and after the trigger point are numbered using negative and positive line numbers respectively. If all the fields of the Trace Record Fields (the Trace Recoord Fields settings in the Debug option attribute page of Project Settings sub-menu in the Options menu) are selected, the result is as shown in Fig 5-7. If No trigger mode is selected or the trigger point has not yet occurred, the sequence number starts from -00001 and decreases 1 sequentially for the trace records (Fig 5-6).

- Program count (PC)
  The program count of the instruction in this trace record.
- Machine code (CODE)
  The machine code of this instruction.
- Disassembled instruction (INSTRUCTION)
  The disassembled mnemonic instruction is disassembled using an HT-IDE3000 utility.
- Execution data (DAT)
  The data content to be executed (read/write).
- Source file name with a line number (FILE-LINE)
  The source file name and the line number of this instruction.
- Source file (SOURCE)
  The source line statement (including symbols).

All the above fields are optional except the sequence number which is always displayed.

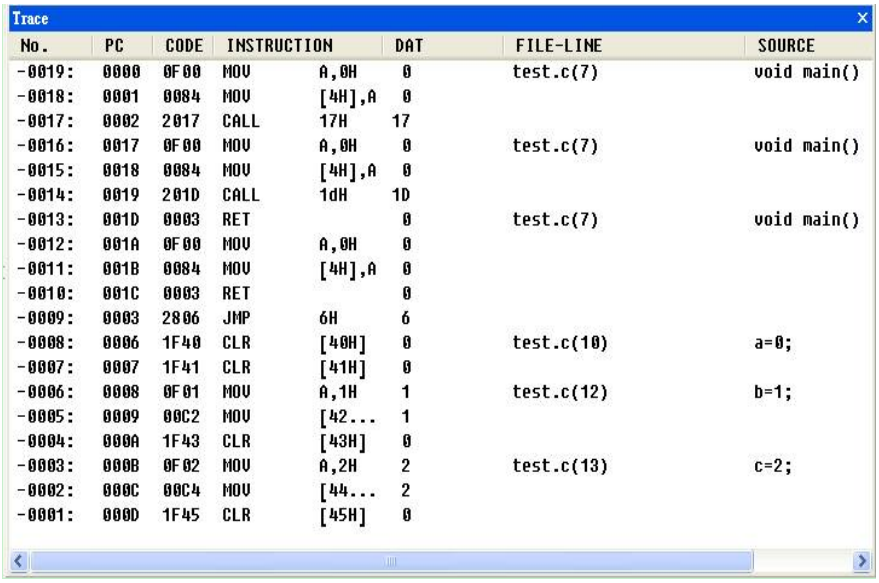



Fig 5-7

**Note:** To set the trace record fields by modifying the Trace Recoord Fields settings in the Debug option attribute page of Project Settings sub-menu in the Options menu.
To view the trace record fields use Trace List command of the Window menu.

→ **Clear the Trace Buffer**

The trace buffer can be cleared by issuing the Reset Trace command. Hereafter, the trace information will be saved from the beginning of the trace buffer. Note that both the Reset command and the Power-On Reset command also clear the trace buffer.

Chapter 6

# Menu - Window

6

The HT-IDE3000 provides various kinds of windows which assist the user to emulate or simulate application programs. These windows (as shown in Fig 6-1) include program Data Memory (RAM), program code memory (ROM), Trace List, Register,Watch , Stack, Program, Output, etc.

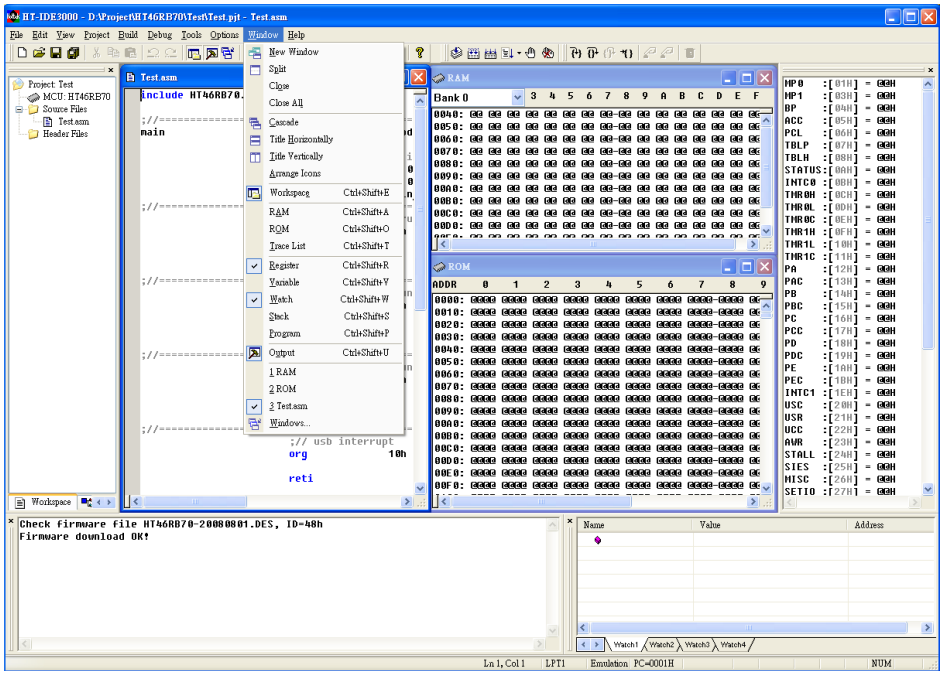



Fig 6-1

# Window Menu Commands

- Workspace

  The Workspace window lists out all of the source files in the project. As shown in Fig. 6-2, here chosen source files can be quickly selected. Files can be added or removed here.

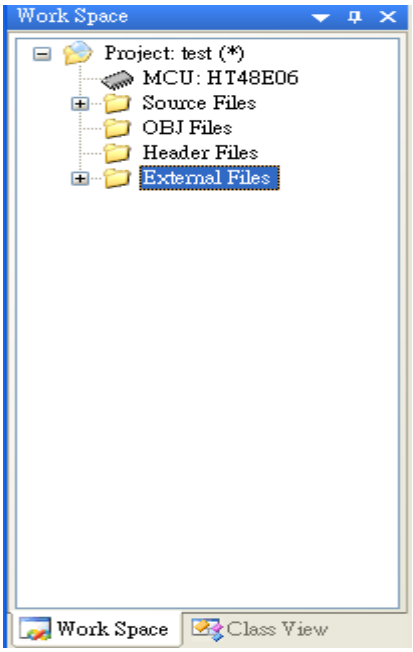



Fig 6-2

- RAM

  The RAM window display the contents of the program Data Memory space as shown in Fig 6-3 The address spaces of the registers are not included in the RAM window because they are displayed in the register window. The contents of the RAM window can be modified directly for debugging purpose. The address displayed vertically is the base address while the horizontal single digit address is the offset. All the digits are displayed in hexadecimal format. The Address field can input an address for direct location and the Column filed is used to specify the number of columns.

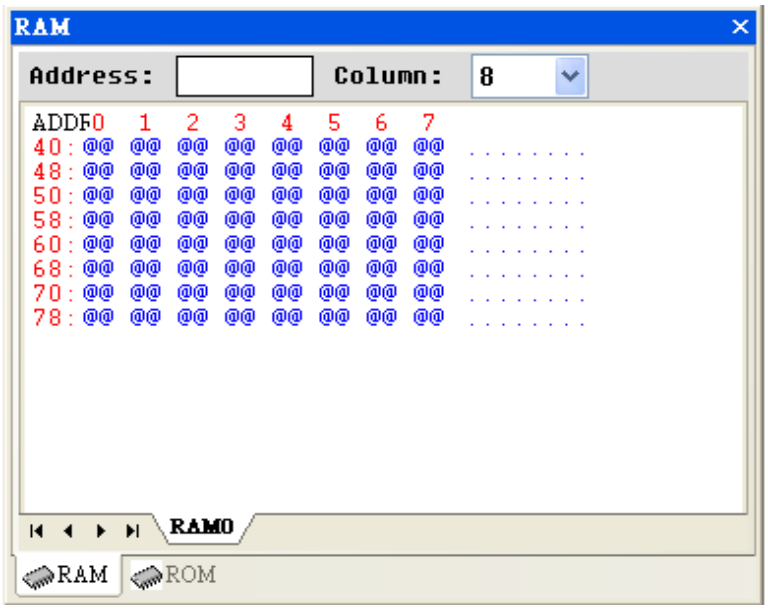



Fig 6-3

- ROM

  The ROM window displays the contents of the program code memory space as shown in Fig 6-4. The ROM address range is from 0 to last address where the last address depends upon the MCU selected in the project. The horizontal and vertical scrollbars can be used to view any address in the ROM window. The contents in ROM window are displayed in hexadecimal format and cannot be modified.

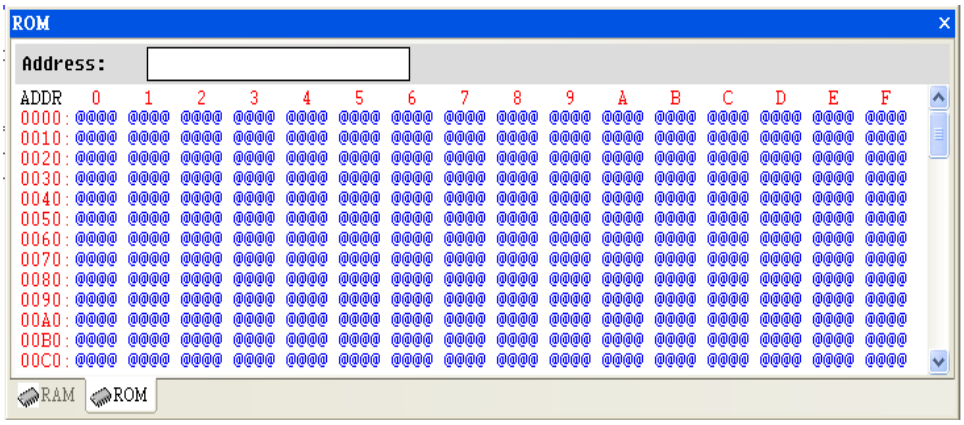



Fig 6-4

- Trace List

  The Trace List window displays the trace record information as shown in Fig 6-5. The

contents of the trace record can be defined in the Debug command in the Options menu. Double click the trace record in the Trace List window will activate the source file window and the cursor will stop at the corresponding line.

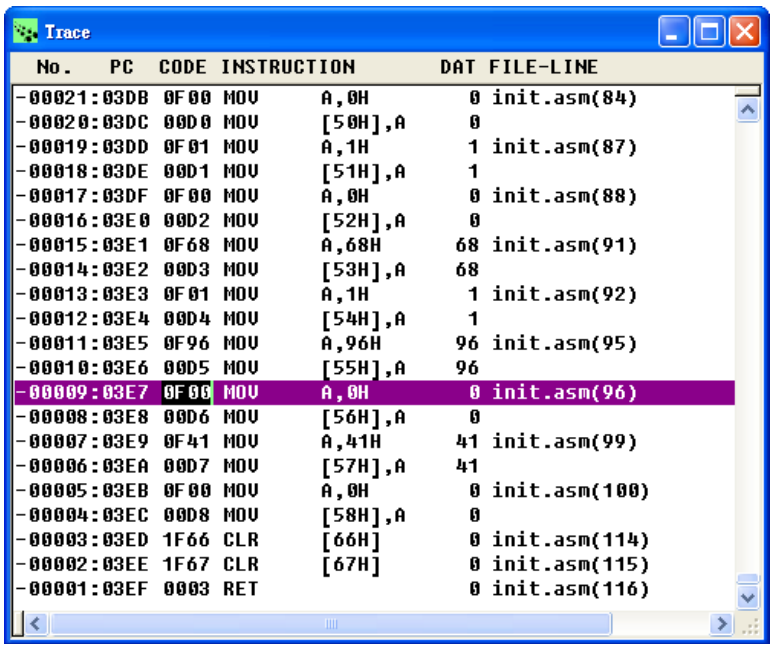



Fig 6-5

- Register

  The Register window displays all the registers defined in the MCU selected in the project. Fig 6-6 shows an example of the Register window of HT48C70-1. The contents of the Register window can be modified for debugging. Note that the Register window is dockable.

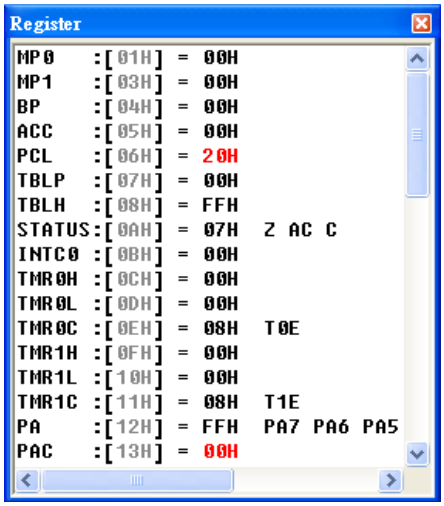

Register
MP0 :[01H] = 00H
MP1 :[03H] = 00H
BP :[04H] = 00H
ACC :[05H] = 00H
PCL :[06H] = 20H
TBLP :[07H] = 00H
TBLH :[08H] = FFH
STATUS:[0AH] = 07H Z AC C
INTC0 :[0BH] = 00H
TMR0H :[0CH] = 00H
TMR0L :[0DH] = 00H
TMR0C :[0EH] = 08H T0E
TMR1H :[0FH] = 00H
TMR1L :[10H] = 00H
TMR1C :[11H] = 08H T1E
PA :[12H] = FFH PA7 PA6 PA5
PAC :[13H] = 00H

Fig 6-6

- Watch

  The Watch window displays the memory addresses and contents of the specified symbols defined in the data sections, i.e., in the RAM space.

  – The contents of the registers can also be displayed by typing the symbol name or register name and then pressing the Enter key. The memory address and contents of the specified symbol or register will be displayed to the right of the symbol.
  – Display the specified symbol that belongs to the RAM or ROM space.
  – Address is displayed in hexadecimal format, and data is displayed in decimal, hexadecimal or binary format as shown in Fig 6-7. The symbol and their corresponding data will be saved by the HT-IDE3000 and displayed the next time the Watch window is opened. The symbols can be deleted from Watch window by pressing the delete key. Note that the Watch window is dockable.

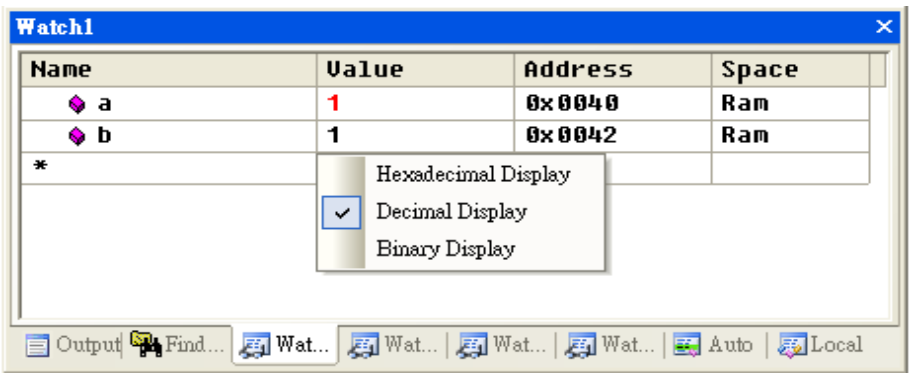



Fig 6-7

- Stack

  The Stack window displays the contents of the stack buffer for the MCU selected in the current project. The maximum stack level is dependent upon the MCU selected. Fig 6-8 shows an example of the Stack window. The growth of the stack is numbered from 0. The number is increased by 1 for a push operation (CALL instruction or interrupt) and decreased by 1 for a pop operation (RET or RETI instructions). The top stack line is highlighted. E.g. The 01: shown in Fig 6-8 is the top stack line. While executing a RET or RETI instruction, the program line number specified in the top stack line (134 in this example) will be used as the next instruction line to be executed. Also, the line above the top stack line (00: in this example) will be used as the new top stack line. If there is no stack line anymore, no line in the Stack window will be highlighted. The format of the stack line is:

**Stack_level: program_counter source_file_name(line_number)**

where the stack_level is the level number of the stack, program_counter is the hexadecimal return address of the calling procedure or the program address of the interrupted instruction, source_file_name is the complete name of the source file containing the calling or interrupted instruction, and line_number is the decimal line number of the instruction after the call instruction or interrupted instruction in the source file.

Fig 6-8

- Variable

This window can view and modify variable values, including two tabs:

- Auto tab, this tab can observe and set both local variables and global variables related to the current function.

- Local tab, this tab can observe and set local variables related to the current function.

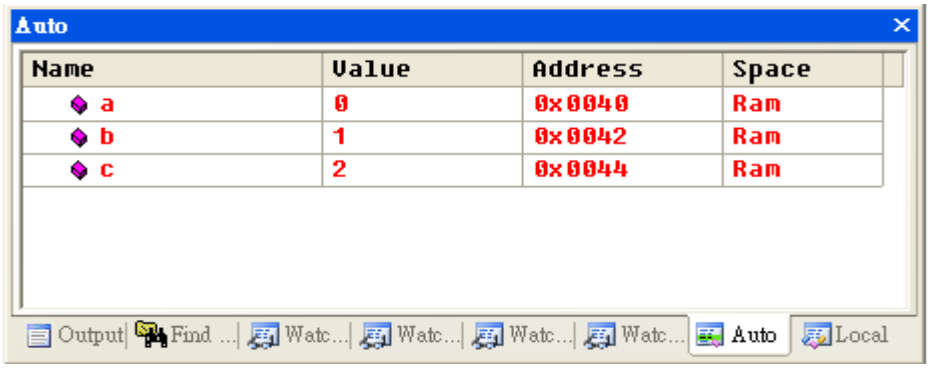



Fig 6-9

- Program

The Program window displays the program code memory or ROM in disassembly format. The address range is from 0 to last address where the last address depends upon the MCU selected in the project.

- Disassembly

  The Disassembly Window shows mixed high-level source code and its associated assembler code. Each instruction is marked with code coverage indicators that show execution status.

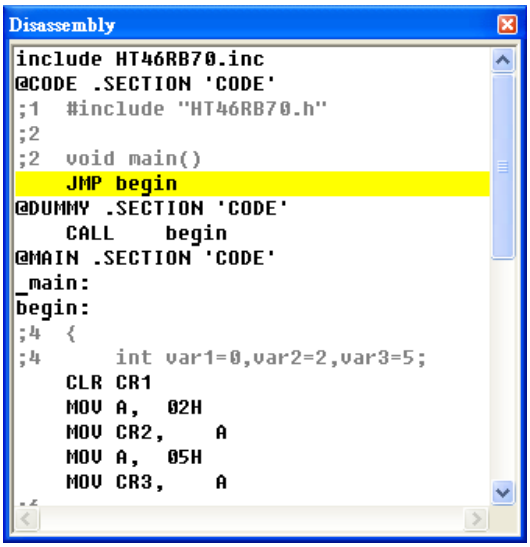



Fig 6-10

- Output

  The Output window shows the system messages from the HT-IDE3000 when the Build/Rebuild All commands are executing. By double clicking on the error message line, the window containing the source file will be displayed and the corresponding line containing the error highlighted.

  The Output window also displays the Program Checksum and the Program Verify Code. This can assist the user to know if the program has been modified

P a r t I I

# Development Language and Tools

Chapter 7

# Assembly Language and Cross Assembler

7

Assembly-Language programs are written as source files. They can be assembled into object files by the Cross Assembler. Object files are combined by the Cross Linker to generate a task file.

A source program is made up of statements and look up tables, giving directions to the Cross Assembler at assembly time or to the processor at run time. Statements are constituted by mnemonics (operations), operands and comments.

## Notational Conventions

The following list describes the notations used by this document.

| Example of convention | Description of convention |
|---|---|
| [*optional items*] | Syntax elements that are enclosed by a pair of brackets are optional. For example, the syntax of the command line is as follows:<br>**HASM** [*options*] *filename* [;]<br>In the above command line, options and semicolon; are both optional, but filename is required, except for the following case: |

| | |
|---|---|
| | Brackets in the instruction operands. In this case, the brackets refer to memory address. |
| {*choice1* \| *choice2*} | Braces and vertical bars stand for a choice between two or more items. Braces enclose the choices whereas vertical bars separate the choices. Only one item can be chosen. |
| Repeating elements… | Three dots following an item signify that more items with the same form may be entered. For example, the directive PUBLIC has the following form:<br>**PUBLIC** *name1* [,*name2* [,…]]<br>In the above form, the three dots following name2 indicate that many names can be entered as long as each is preceded by a comma. |

# Statement Syntax

The construction of each statement is as follows:

[*name*][*operation*][*operands*][*;comment*]

- All fields are optional.
- Each field (except the comment field) must be separated from other fields by at least one space or one tab character.
- Fields are not case-sensitive, i.e., lower-case characters are changed to upper-case characters before processing.

## Name

Statements can be assigned labels to enable easy access by other statements. A name consists of the following characters:

```
A~Z  a~z  0~9  ?  -  @
```

with the following restrictions :

- 0~9 cannot be the first character of a name

- ? cannot stand alone as a name
- Only the first 31 characters are recognized

### Operation

The operation defines the statement action of which two types exist, directives and instructions. Directives give directions to the Cross Assembler, specifying the manner in which the Cross Assembler is to generate the object code at assembly time. Instructions, on the other hand, give directions to the processor. They are translated to object code at assembly time, the object code in turn controls the behavior of the processor at run time.

### Operand

Operands define the data used by directives and instructions. They can be made up of symbols, constants, expressions and registers.

### Comment

Comments are the descriptions of codes. They are used for documentation only and are ignored by the Cross Assembler. Any text following a semicolon is considered a comment.

## Assembly Directives

Directives give direction to the Cross Assembler, specifying the manner in which the Cross Assembler generates object code at assembly time. Directives can be further classified according to their behavior as described below.

### Conditional Assembly Directives

The conditional block has the following form:

**IF**
*statements*
[**ELSE**
*statements*]
**ENDIF**

→ **Syntax**
**IF** *expression*
**IFE** *expression*

- Description

  The directives **IF** and **IFE** test the expression following them.

  The **IF** directive grants assembly if the value of the expression is true, i.e. non-zero.

  The **IFE** directive grants assembly if the value of the expression is false, i.e. zero.

- Example

```
IF      debugcase
        ACC1        equ 5
        extern      username: byte
ENDIF
```

  In this example, the value of the variable `ACC1` is set to 5 and the username is declared as an external variable if the symbol debugcase is evaluated as true, i.e. nonzero.

→ **Syntax**

**IFDEF** *name*
**IFNDEF** *name*

- Description

  The directives **IFDEF** and **IFNDEF** test whether or not the given name has been defined. The **IFDEF** directive grants assembly only if the name is a label, a variable or a symbol. The **IFNDEF** directive grants assembly only if the name has not yet been defined. The conditional assembly directives support a nesting structure, with a maximum nesting level of 7.

- Example

```
IFDEF       buf_flag
            buffer  DB  20 dup (?)
ENDIF
```

  In this example, the buffer is allocated only if the buf_flag has been previously defined.

## File Control Directives

→ **Syntax**

**INCLUDE** *file-name*
or
**INCLUDE** *file-name*

- Description

  This directive inserts source codes from the source file given by file-name into the current source file during assembly. Cross Assembler supports at most 7 nesting levels.

- Example

```
INCLUDE     macro.def
```

  In this example, the Cross Assembler inserts the source codes from the file macro.def

into the current source file.

→ **Syntax**
**PAGE** *size*

- Description
  This directive specifies the number of the lines in a page of the program listing file. The page size must be within the range from 10 to 255, the default page size is 60.
- Example
  ```
  PAGE 57
  ```
  This example sets the maximum page size of the listing file to 57 lines.

→ **Syntax**
**.LIST**
**.NOLIST**

- Description
  The directives **.LIST** and **.NOLIST** decide whether or not the source program lines are to be copied to the program listing file. **.NOLIST** suppresses copying of subsequent source lines to the program listing file. **.LIST** restores the copying of subsequent source lines to the program listing file. The default is **.LIST**.
- Example
  ```
  .NOLIST
  mov   a, 1
  mov   b1, a
  .LIST
  ```
  In this example, the two instructions in the block enclosed by **.NOLIST** and **.LIST** are suppressed from copying to the source listing file.

→ **Syntax**
**.LISTMACRO**
**.NOLISTMACRO**

- Description
  The directive **.LISTMACRO** causes the Cross Assembler to list all the source statements, including comments, in a macro. The directive **.NOLISTMACRO** suppresses the listing of all macro expansions. The default is **.NOLISTMACRO**.

→ **Syntax**
**.LISTINCLUDE**
**.NOLISTINCLUDE**

- Description
  The directive **.LISTINCLUDE** inserts the contents of all included files into the program listing. The directive **.NOLISTINCLUDE** suppresses the addition of included files. The default is **.NOLISTINCLUDE**.

→ **Syntax**
**MESSAGE** *'text-string'*

- Description
  The directive **MESSAGE** directs the Cross Assembler to display the text-string on the screen. The characters in the *text-string* must be enclosed by a pair of single quotation marks.

→ **Syntax**
**ERRMESSAGE** *'error-string'*

- Description
  The directive **ERRMESSAGE** directs the Cross Assembler to issue an error. The characters in the *error-string* must be enclosed by a pair of single quotation marks.

## Program Directives

→ **Syntax ( comment )**
; text

- Description
  A comment consists of characters preceded by a semicolon (;) and terminated by an embedded carriage-return/line-feed.

→ **Syntax**
*name* **.SECTION** [*align*] [*combine*] *'class'*

- Description
  The **.SECTION** directive marks the beginning of a program section. A program section is a collection of instructions and/or data whose addresses are relative to the section beginning with the name which defines that section. The name of a section can be unique or be the same as the name given to other sections in the program. Sections with the same complete names are treated as the same section. The optional align type defines the alignment of the given section. It can be one of the following:

  **BYTE** uses any byte address (the default align type)
  **WORD** uses any word address
  **PARA** uses a paragraph address
  **PAGE** uses a page address

  For the CODE section, the byte address is in a single instruction unit. **BYTE** aligns the section at any instruction address, **WORD** aligns the section at any even instruction address, **PARA** aligns the section at any instruction address which is a multiple of 16, and **PAGE** aligns the section at any instruction address with a multiple of 256.

  For **DATA** sections, the byte address is in one byte units (8 bits/byte). **BYTE** aligns the section at any byte address, **WORD** aligns the section at any even address, **PARA** aligns the section at any address which is a multiple of 16, and **PAGE** aligns the

section at any address which is a multiple of 256. The optional combine type defines the way of combining sections having the same complete name (section and class name). It can be any one of the following:

– COMMON

Creates overlapping sections by placing the start of all sections with the same complete name at the same address. The length of the resulting area is the length of the longest section.

– AT *address*

Causes all label and variable addresses defined in a section to be relative to the given address. The address can be any valid expression except a forward reference. It is an absolute address in a specified ROM/RAM bank and must be within the ROM/RAM range.

If no *combine* type is given, the section is combinative, i.e., this section can be concatenated with all sections having the same complete name to form a single, contiguous section. The *class* type defines the sections that are to be loaded in the contiguous memory. Sections with the same class name are loaded into the memory one after another. The class name **CODE** is used for sections stored in ROM, and the class name **DATA** is used for sections stored in RAM. The complete name of a section consists of a section name and a class name. The named section includes all codes and data below (after) it until the next section is defined.

→ **Syntax**
**ROMBANK** *banknum section-name* [,*section-name*,...]

- Description
  This directive declares which sections are allocated to the specified ROM bank. The banknum specifies the ROM bank, ranging from 0 to the maximum bank number of the destination MCU. The *section-name* is the name of the section defined previously in the program. More than one section can be declared in a bank as long as the total size of the sections does not exceed the bank size of 8K words. If this directive is not declared, bank 0 is assumed and all CODE sections defined in this program will be in bank 0. If a CODE section is not declared in any ROM bank, then bank 0 is assumed.

→ **Syntax**
**RAMBANK** *banknum section-name* [,*section-name*,...]

- Description
  This directive is similar to **ROMBANK** except that it specifies the RAM bank, the size of RAM bank is 256 bytes.

→ **Syntax**
**END**

- Description

This directive marks the end of a program. Adding this directive to any included file should be avoided.

→ **Syntax**
**ORG** *expression*

- Description
  This directive sets the location counter to expression. The subsequent code and data offsets begin at the new offset specified by expression. The code or data offset is relative to the beginning of the section where the directive ORG is defined. The attribute of a section determines the actual value of offset, absolute or relative.
- Example

```
ORG 8
mov A, 1
```

  In this example, the statement mov A, 1 begins at location 8 in the current section.

→ **Syntax**
**PUBLIC** *name1* [,*name2* [,...]]
**EXTERN** *name1*:*type* [,*name2*:*type* [,...]]

- Description
  The PUBLIC directive marks the variable or label specified by a name that is available to other modules in the program. The **EXTERN** directive, on the other hand, declares an external variable, label or symbol of the specified name and type. The type can be one of the three types: **BYTE**, **BIT** (these two types are for data variables), and **NEAR** (a label type and used by call or jmp).
- Example

```
PUBLIC   start, setflag
EXTERN   tmpbuf:byte
CODE            .SECTION 'CODE'
start:
        mov     a, 55h
        call    setflag
        ...
setflag proc
        mov     tmpbuf, a
        ret
setflag endp
end
```

  In this example, both the label start and the procedure setflag are declared as public variables. Programs in other sources may refer to these variables. The variable tmpbuf is also declared as external. There should be a source file defining a byte that is named tmpbuf and is declared as a public variable.

→ **Syntax**
*name* **PROC**

*name* **ENDP**

- Description

  The **PROC** and **ENDP** directives mark a block of code which can be called or jumped to from other modules. The **PROC** creates a label name which stands for the address of the first instruction of a procedure. The Cross Assembler will set the value of the label to the current value of the location counter.

- Example

```
toggle PROC
mov    tmpbuf, a
mov    a, 1
xorm   a, flag
mov    a, tmpbuf
ret
toggle ENDP
```

→ **Syntax**

[*label*:] **DC** *expression1* [,*expression2* [,...]]

- Description

  The **DC** directive stores the value of *expression1*, *expression2* etc. in consecutive memory locations. This directive is used for the CODE section only. The bit size of the result value is dependent on the ROM size of the MCU. The Cross Assembler will clear any redundant bits; *expression1* has to be a value or a label. This directive may also be employed to setup the table in the code section.

- Example

```
table: DC    0128H, 025CH
```

  In this example, the Cross Assembler reserves two units of ROM space and also stores 0128H and 025CH into these two ROM units.

## Data Definition Directives

An assembly language program consists of one or more statements and comments. A statement or comment is a composition of characters, numbers, and names. The assembly language supports integer numbers. An integer number is a collection of binary, octal, decimal, or hexadecimal digits along with an optional radix. If no radix is given, the Cross Assembler uses the default radix (decimal). The table lists the digits that can be used with each radix.

| Radix | Type | Digits |
|---|---|---|
| B | Binary | 01 |
| O | Octal | 01234567 |
| D | Decimal | 0123456789 |

| | | |
|---|---|---|
| H | Hexadecimal | 0123456789ABCDEF |

→ **Syntax**

[*name*] **DB** *value1* [,*value2* [,...]]
[*name*] **DBIT**
[*name*] **DB** *repeated-count* **DUP**(?)

- Description

  These directives reserve the number of bytes specified by the repeated-count or reserve bytes only. *value1* and *value2* should be ? due to the microcontroller RAM . The Cross Assembler will not initialize the RAM data. **DBIT** reserves a bit. The content ? denotes uninitialized data, i.e., reserves the space of the data. The Cross Assembler will gather every 8 **DBIT** together and reserve a byte for these 8 DBIT variables.

- Example

```
DATA    .SECTION    'DATA'
tbuf    DB  ?
flag1   DBIT
sbuf    DB  ?
cflag   DBIT
```

  In this example, the Cross Assembler reserves byte location 0 for tbuf, bit 0 of location 1 for flag1, location 2 for sbuf and bit 1 of location 1 for cflag.

→ **Syntax**

*name* **LABEL** **{BIT|BYTE|WORD}**

- Description

  The name with the data type has the same address as the following data variable

- Example

```
lab1    LABEL    WORD
d1      DB  ?
d2      DB  ?
```

  In this example, d1 is the low byte of lab1 and d2 is the high byte of lab1.

→ **Syntax**

*name* **EQU** *expression*

- Description

  The **EQU** directive creates absolute symbols, aliases, or text symbols by assigning an expression to name. An absolute symbol is a name standing for a 16-bit value; an alias is a name representing another symbol; a text symbol is a name for another combination of characters. The name must be unique, i.e. not having been defined previously. The expression can be an integer, a string constant, an instruction mnemonic, a constant expression, or an address expression.

- Example

```
accreg  EQU  5
bmove   EQU  mov
```

In this example, the variable accreg is equal to 5, and bmove is equal to the instruction mov.

## Macro Directives

Macro directives enable a block of source statements to be named, and then that name to be re-used in the source file to represent the statements. During assembly, the Cross Assembler automatically replaces each occurrence of the macro name with the statements in the macro definition.

A macro can be defined at any place in the source file as long as the definition precedes the first source line that calls this macro. In the macro definition, the macro to be defined may refer to other macros which have been previously defined. The Cross Assembler supports a maximum of 7 nesting levels.

→ **Syntax**

*name* **MACRO** [*dummy-parameter* [,...]]
*statements*
**ENDM**

The Cross Assembler supports a directive LOCAL for the macro definition.

→ **Syntax**

*name* **LOCAL** *dummy-name* [,...]

- Description

  The **LOCAL** directive defines symbols available only in the defined macro. It must be the first line following the **MACRO** directive, if it is present. The dummy-name is a temporary name that is replaced by a unique name when the macro is expanded. The Cross Assembler creates a new actual name for dummy-name each time the macro is expanded. The actual name has the form ??digit, where digit is a hexadecimal number within the range from 0000 to FFFF. A label should be added to the **LOCAL** directive when labels are used within the **MACRO**/**ENDM** block. Otherwise, the Cross Assembler will issue an error if this **MACRO** is referred to more than once in the source file.

  In the following example, tmp1 and tmp2 are both dummy parameters, and are replaced by actual parameters when calling this macro. label1 and label2 are both declared **LOCAL**, and are replaced by ??0000 and ??0001 respectively at the first reference, if no other **MACRO** is referred. If no **LOCAL** declaration takes place, label1 and label2 will be referred to labels, similar to the declaration in the source program. At the second reference of this macro, a multiple define error message is displayed.

```
Delay   MACRO   tmp1, tmp2
        LOCAL   label1, label2
        mov     a, 70h
        mov     tmp1, a
```

```
label1:
        mov         tmp2, a
label2:
        clr         wdt1
        clr         wdt2
        sdz         tmp2
        jmp         label2
        sdz         tmp1
        jmp         label1
        ENDM
```

The following source program refers to the macro Delay ...

```
; T.ASM
;  Sample program for MACRO.
.ListMacro
Delay MACRO  tmp1, tmp2
      LOCAL  label1, label2
      mov    a, 70h
      mov    tmp1, a
label1:
      mov    tmp2, a
label2:
      clr    wdt1
      clr    wdt2
      sdz    tmp2
      jmp    label2
      sdz    tmp1
      jmp    label1
      ENDM

data .section 'data'
BCnt db ?
SCnt db ?

code .section at 0 'code'
Delay BCnt, SCnt
end
```

The Cross Assembler will expand the macro Delay as shown in the following listing file. Note that the offset of each line in the macro body, from line 4 to line 17, is 0000. Line 24 is expanded to 11 lines and forms the macro body. In addition the formal parameters, tmp1 and tmp2, are replaced with the actual parameters, BCnt and SCnt, respectively.

```
File: T.asm         Holtek Cross-Assembler  Version 2.80      Page 1

   1  0000              ; T.ASM
   2  0000              ;  Sample program for MACRO.
   3  0000              .ListMacro
   4  0000              Delay MACRO  tmp1, tmp2
   5  0000                    LOCAL  label1, label2
   6  0000                    mov    a, 70h
   7  0000                    mov    tmp1, a
   8  0000              label1:
   9  0000                    mov    tmp2, a
  10  0000              label2:
  11  0000                    clr    wdt1
  12  0000                    clr    wdt2
  13  0000                    sdz    tmp2
  14  0000                    jmp    label2
  15  0000                    sdz    tmp1
  16  0000                    jmp    label1
  17  0000                    ENDM
  18  0000
  19  0000              data .section 'data'
  20  0000  00          BCnt db ?
  21  0001  00          SCnt db ?
  22  0002
  23  0000              code .section at 0 'code'
  24  0000              Delay BCnt, SCnt
  24  0000  0F70      1       mov    a, 70h
  24  0001  0080     R1       mov    BCnt, a
  24  0002            1  ??0000:
  24  0002  0080     R1       mov    SCnt, a
  24  0003            1  ??0001:
  24  0003  0001      1       clr    wdt1
  24  0004  0005      1       clr    wdt2
  24  0005  1780     R1       sdz    SCnt
  24  0006  2803      1       jmp    ??0001
  24  0007  1780     R1       sdz    BCnt
  24  0008  2802      1       jmp    ??0000
  25  0009              end

        0 Errors
```

# Assembly Instructions

The syntax of an instruction has the following form：

[*name*:] mnemonic [*operand1* [,*operand2*] ] [; *comment*]

where

| | | |
|---|---|---|
| *name*: | → | label name |
| *mnemonic* | → | instruction name (keywords) |
| *operand1* | → | registers |
| | | memory address |
| *operand2* | → | registers |
| | | memory address |
| | | immediate value |

## Name

A name is made up of letters, digits, and special characters, and is used as a label.

## Mnemonic

Mnemonic is an instruction name dependent upon the type of the MCU used in the source program.

## Operand, Operator and Expression

Operands (source or destination) are the argument defining values that are to be acted on by instructions. They can be constants, variables, registers, expressions or keywords. When using the instruction statements, care must be taken to select the correct operand type, i.e. source operand or destination operand. The dollar sign $ is a special operand, namely the current location operand.

An expression consists of many operands that are combined to describe a value or a memory location. The combined operators are evaluated at assembly time. They can contain constants, symbols, or any combination of constants and symbols that are separated by arithmetic operators.

Operators specify the operations to be performed while combining the operands of an expression. The Cross Assembler provides many operators to combine and evaluate operands. Some operators work with integer constants, some with memory values, and some with both. Operators handle the calculation of constant values that are known at the assembly time. The following are some operators provided by the Cross Assembler.

- Arithmetic operators + – * / % ( MOD )
- SHL 和 SHR operators
  - Syntax
    *expression* **SHR** *count*
    *expression* **SHL** *count*

    The values of these shift bit operators are all constant values. The expression is shifted right SHR or left SHL by the number of bits specified by count. If bits are shifted out of position, the corresponding bits that are shifted in are zero-filled. The following are such examples:

```
mov   A, 01110111b   SHR 3   ; result   ACC=00001110b
mov   A, 01110111b   SHL 4   ; result   ACC=01110000b
```

- Bitwise operators NOT、AND、OR、XOR
  - Syntax
    **NOT** *expression*
    *expression1* **AND** *expression2*
    *expression1* **OR** *expression2*

*expression1* **XOR** *expression2*

**NOT** is a bitwise complement.
**AND** is a bitwise AND.
**OR** is a bitwise inclusive OR.
**XOR** is a bitwise exclusive OR.

- OFFSET operator
  - Syntax
    **OFFSET** *expression*

  The **OFFSET** operator returns the offset address of an expression. The expression can be a label, a variable, or other direct memory operand. The value returned by the **OFFSET** operator is an immediate operand.

- LOW、MID 和 HIGH operator
  - Syntax
    **LOW** *expression*
    **MID** *expression*
    **HIGH** *expression*

  The **LOW/MID/HIGH** operator returns the value of an expression if the result of the expression is an immediate value. The **LOW/MID/HIGH** operators will then take the low/middle/ high byte of this value. But if the expression is a label, the **LOW/MID/HIGH** operator will take the values of the low/middle/high byte of the program count of this label.

  For example:

  cs .section at 456H 'code'
  lab1:
  …

  Then:

  mov a,low 9840H →mov a,40H
  mov a,mid 9840H →mov a,84H
  mov a,high 9840H →mov a,98H
  mov a,low lab1 →mov a,56H
  mov a,mid lab1 →mov a,45H
  mov a,high lab1 →mov a,4H

- BANK operator
  - Syntax
    **BANK** *name*

  The **BANK** operator returns the bank number allocated to the section of the name declared. If the name is a label then it returns the rom bank number. If the name is a data variable then it returns the ram bank number. The format of the bank number is the same as the BP defined. For more information of the format please refer to the data sheets of the corresponding MCUs. (Note: The format of the BP might be

different between MCUs.)

Example 1:

```
mov   A, BANK start
mov   BP, A
jmp   start
```

Example 2:

```
mov   A, BANK var
mov   BP, A
mov   A, OFFSET var
mov   MP1, A
mov   A, R1
```

- Operator precedence

| Precedence | Operators |
|---|---|
| 1(Highest) | ( ), [ ] |
| 2 | + , – (unary), LOW, MID, HIGH, OFFSET, BANK |
| 3 | *, /, %, SHL, SHR |
| 4 | +, – (binary) |
| 5 | >(greater than), >=(greater than or equal to), <(less than), <= (less than or equal to) |
| 6 | = = (equal to), !=(not equal to) |
| 7 | ! (bitwise NOT) |
| 8 | & (bitwise AND) |
| 9(Lowest) | \| (bitwise OR), ^ (bitwise XOR) |

# Miscellaneous

## Forward References

The Cross Assembler allows reference to labels, variable names, and other symbols before they are declared in the source code (forward named references). But symbols to the right of EQU are not allowed to be forward referenced.

## Local Labels

A local label is a label with a fixed form such as $number. The number can be 0~29. The function of a local label is the same as a label except that the local label can be used repeatedly. The local label should be used between any two consecutive labels and the same local label name may used between other two consecutive labels. The Cross Assembler will transfer every local label into a unique label before assembling the source file. At most 30 local labels can be defined between two consecutive labels.

Example

```
Label1:                    ; label
```

```
            $1:                     ;; local label
                mov a, 1
                jmp $3
            $2:                     ;; local label
                mov a, 2
                jmp $1
            $3:                     ;; local label
                jmp $2
Label2:                             ; labe1
                Jmp $1
            $0:                     ;; local label
                jmp Label1
            $1: jmp $0
Label3:
```

## Reserved Assembly Language Words

The following tables list all reserved words used by the assembly language.

- Reserved Names (directives, operators)

| | | | |
|---|---|---|---|
| $ | DUP | INCLUDE | NOT |
| * | | LABEL | OFFSET |
| + | ELSE | .LIST | OR |
| - | END | .LISTINCLUDE | ORG |
| . | ENDIF | .LISTMACRO | PAGE |
| / | ENDM | LOCAL | PARA |
| = | ENDP | LOW | PROC |
| ? | EQU | MACRO | PUBLIC |
| [ ] | ERRMESSAGE | MESSAGE | RAMBANK |
| AND | EXTERN | MID | ROMBANK |
| BANK | HIGH | MOD | .SECTION |
| BYTE | IF | NEAR | SHL |
| DB | IFDEF | .NOLIST | SHR |
| DBIT | IFE | .NOLISTINCLUDE | WORD |
| DC | IFNDEF | .NOLISTMACRO | XOR |

- Reserved Names (instruction mnemonics)

| | | | |
|---|---|---|---|
| ADC | HALT | RLCA | SUB |
| ADCM | INC | RR | SUBM |
| ADD | INCA | RRA | SWAP |
| ADDM | JMP | RRC | SWAPA |
| AND | MOV | RRCA | SZ |
| ANDM | NOP | SBC | SZA |
| CALL | OR | SBCM | TABRDC |
| CLR | ORM | SDZ | TABRDL |
| CPL | RET | SDZA | XOR |
| CPLA | RETI | SET | XORM |
| DAA | RL | SIZ | |
| DEC | RLA | SIZA | |
| DECA | RLC | SNZ | |

- Reserved Names (registers names)

| | | | |
|---|---|---|---|
| A | WDT | WDT1 | WDT2 |

# Cross Assembler Options

The Cross Assembler options can be set via the Options menu Project command in HT-IDE3000. The Cross Assembler Options is located on the center part of the Project Option dialog box, as shown in Fig 7-1.

The symbols could be defined in the Define Symbol edit box.

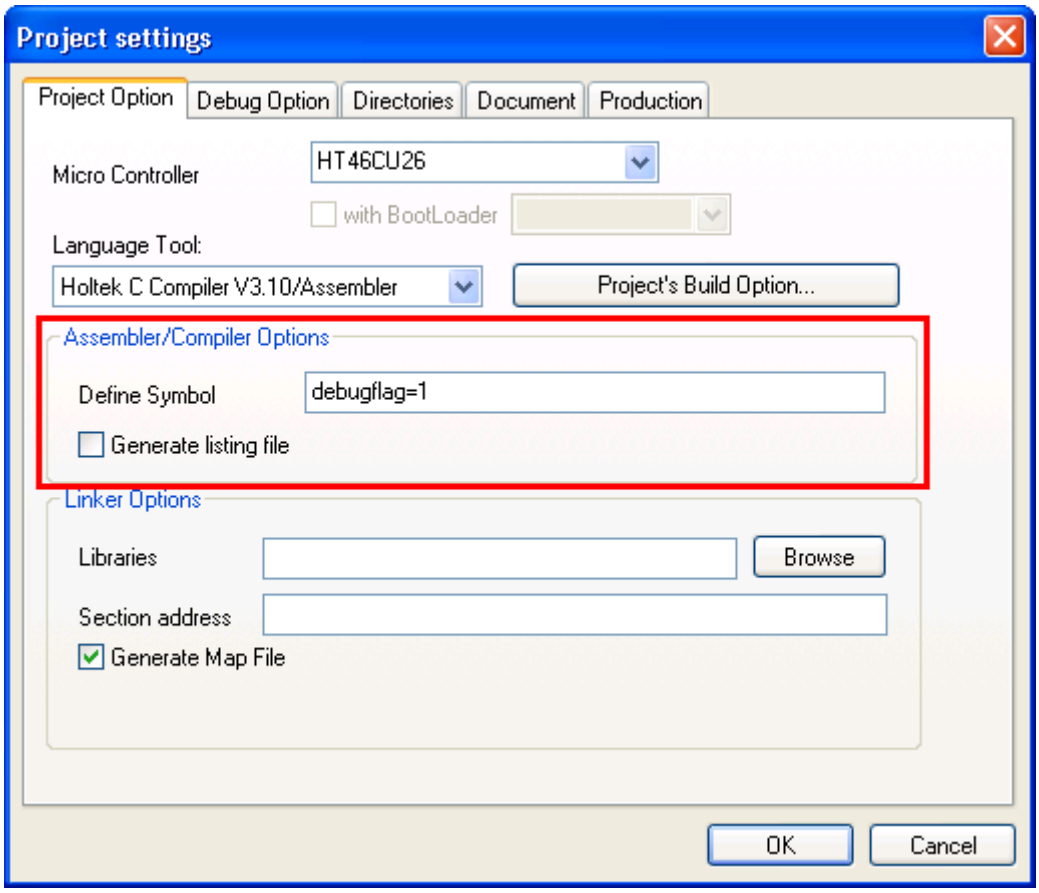



Fig 7-1

→ **Syntax**

*symbol1* [=*value1*] [,*symbol2* [=*value2*] [,...]]

- Example

  debugflag=1, newver=3

The check box of the Generate listing file is used to decide whether the listing file should be generated or not. If the check box is checked, the listing file will be generated. Otherwise, it won't be generated.

– There is an assembly case sensitive check box in the Project's Build Opion menu. If the check box is checked, it represents case-sensitive. When programming in different languages, this check box is checked in general. If the check box is not checked, it is not case-sensitive.

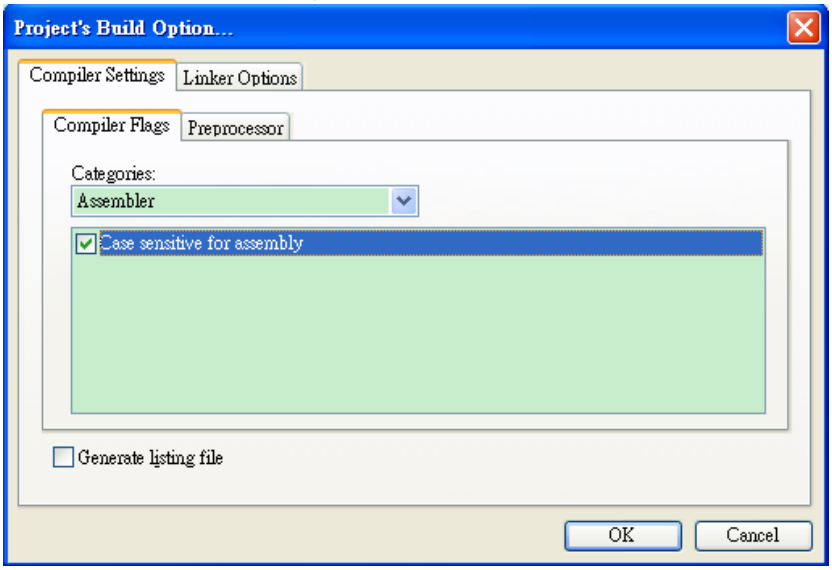



Fig 7-2

# Assembly Listing File Format

The Assembly Listing File contains the source program listing and summary information. The first line of each page is a title line which include company name, the Cross Assembler version number, source file name, date/time of assembly and page number.

## Source Program Listing

Each line in the source program has the following syntax:

*line-number offset* [*code*] *statement*

- *Line-number* is the number of the line starting from the first statement in the assembly source file (4 decimal digits).
- The 2nd field – *offset* – is the offset from the beginning of the current section to the code (4 hexadecimal digits)

- The 3rd field – *code* – is present only if the statement generates code or data (two hexadecimal 4-digit data)

  The code shows the numeric value in hexadecimal if the value is known at assembly time. Otherwise, a proper flag will indicate the action required to compute the value. The following two flags may appear behind the code field.

  - **R** → relocatable address (Cross Linker must resolve)
  - **E** → external symbol (Cross Linker must resolve)

  The following flag may appear before the code field

  **=** → **EQU** or equal-sign directive

  The following 2 flags may appear in the code field

  **----** → section address (Cross Linker must resolve)

  nn[xx] → **DUP** expression: nn **DUP**(?)

- The 4th field – statement – is the source statement shown exactly as it appears in the source file, or as expanded by a macro. The following flags may appear before a statement.

  - **n** → Macro-expansion nesting level
  - **C** → line from **INCLUDE** file

- Summary

```
0         1         2         3         4         5         6
12345678901234567890123456789012345678901234567890123456789...
llll  oooo hhhh hhhh EC source-program-statement
                    Rn
```

  llll → line number (4 digits, right alignment)

  oooo → offset of code (4 digits)

  hhhh → two 4-digits for opcode

  **E** → external reference

  **C** → statement from included file

  **R** → relocatable name

  **n** → Macro-expansion nesting level

## Summary of Assembly

The total warning number and total error number is the information provided at the end of the Cross Assembler listing file.

## Miscellaneous

If any errors occur during assembly, each error message and error number will appear directly below the statement where the error occurred.

→ **Example of Assembly Listing File**

```
File: SAMPLE.ASM    Holtek Cross-Assembler  Version 2.86      Page 1


 1  0000              page 60
 2  0000              message    'Sample Program 1'
 3  0000
 4  0000              .listinclude
 5  0000              .listmacro
 6  0000
 7  0000              #include "sample.inc"

 1  0000            C pa    equ    [12h]
 2  0000            C pac   equ    [13h]
 3  0000            C pb    equ    [14h]
 4  0000            C pbc   equ    [15h]
 5  0000            C pc    equ    [16h]
 6  0000            C pcc   equ    [17h]
 7  0000            C

 8  0000
 9  0000              extern extlab : near
10  0000              extern extb1 : byte
11  0000
12  0000              clrpb macro
13  0000              clr pb
14  0000              endm
15  0000
16  0000              clrpa macro
17  0000              mov a, 00h
18  0000              mov pa, a
19  0000              clrpb
20  0000              endm
21  0000
22  0000              data .section 'data'
23  0000  00          b1    db ?
24  0001  00          b2    db ?
25  0002  00          bit1  dbit
26  0003
27  0000              code .section 'code'
28  0000  0F55          mov  a, 055h
29  0001  0080      R   mov  b1, a
30  0002  0080      E   mov  extb1, a
31  0003  0FAA          mov  a, 0aah
32  0004  0093          mov  pac, a
33  0005                clrpa
33  0005  0F00       1  mov a, 00h
33  0006  0092       1  mov [12h], a
33  0007             1  clrpb
33  0007  1F14       2  clr [14h]
34  0008  0700      R   mov  a, b1
35  0009  0F00      E   mov  a, bank extlab
36  000A  0F00      E   mov  a, offset extb1
37  000B  2800      E   jmp  extlab
38  000C
39  000C  1234 5678     dw   1234h, 5678h, 0abcdh, 0ef12h
          ABCD EF12
40  0010                end

      0 Errors
```

Chapter 8

# Cross Linker

8

## What the Cross Linker Does

The Cross Linker creates task files from the object files generated by the Cross Assembler or the C compiler. The Cross Linker combines both code and data in the object files and searches the named libraries to resolve external references to routines and variables. It also locates the code and data sections at the specified memory address or at the default address, if no explicit address is specified. Finally, the Cross Linker copies both the program codes and other information to the task file. It is this task file that is loaded by the IDE Integrated Development Environment, into the ICE In-Circuit Emulator, for debugging. The libraries included by the Cross Linker were generated by the library manager.

## Cross Linker Options

The options specify and control the tasks performed by Cross Linker. In chapter 3, Option Menu, Project command provides a dialog box, Cross Linker Options, to specify these options to the Cross Linker. These options are:

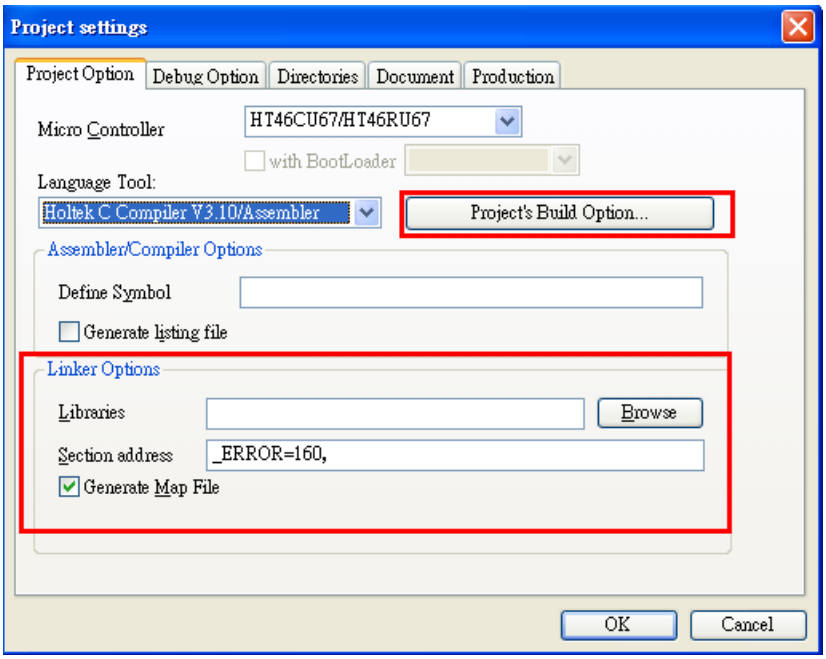



Fig 8-1

## Libraries

- Syntax
  *libfile1*[,*libfile2*...]

  This option informs the Cross Linker to search the specified library files if the input object files refer to a procedure or variable which is not defined in any of the object files. If a module of a library file contains the referred procedure or variable, then only this module, not the whole library file will be included in the output task file. (refer to Chapter 9 Library Manager)

## Section Address

- Syntax
  *section_name*=*address*[,*section_name*=*address*]...

  This option specifies the address of the sections; section_name is the name of the section that is to be addressed. The section_name must be defined in at least one input object file, otherwise a warning will occur. The address is the specified address whose format is xxxx in hexadecimal format.

## Generate Map File

The check box of this option is to specify whether the map file is generated or not.

## Linker Options

Linker options is only available for the Compiler V3.10/Assembler.

**Optimize data memory**：If not nesting interrupts occur in the project,select the option can save data memory.

**Remove unused function**：If a function is not called, then the system will not assign space for it, this option is enabled by default.

**Uninitialized global/static varibles are automatically set to 0**：If a global has no initial value, the default initial value is 0, this value will be cleared when the program starts running.

**Warn if the address of the alias variable is overlap**：Check whether the address of the alias variable is overlapping or not. If the address is address is overlapping , then a warning will be generated.

**Arrange the ROM space by address order**：linker will arrange the function in a small space priority if not select this option.

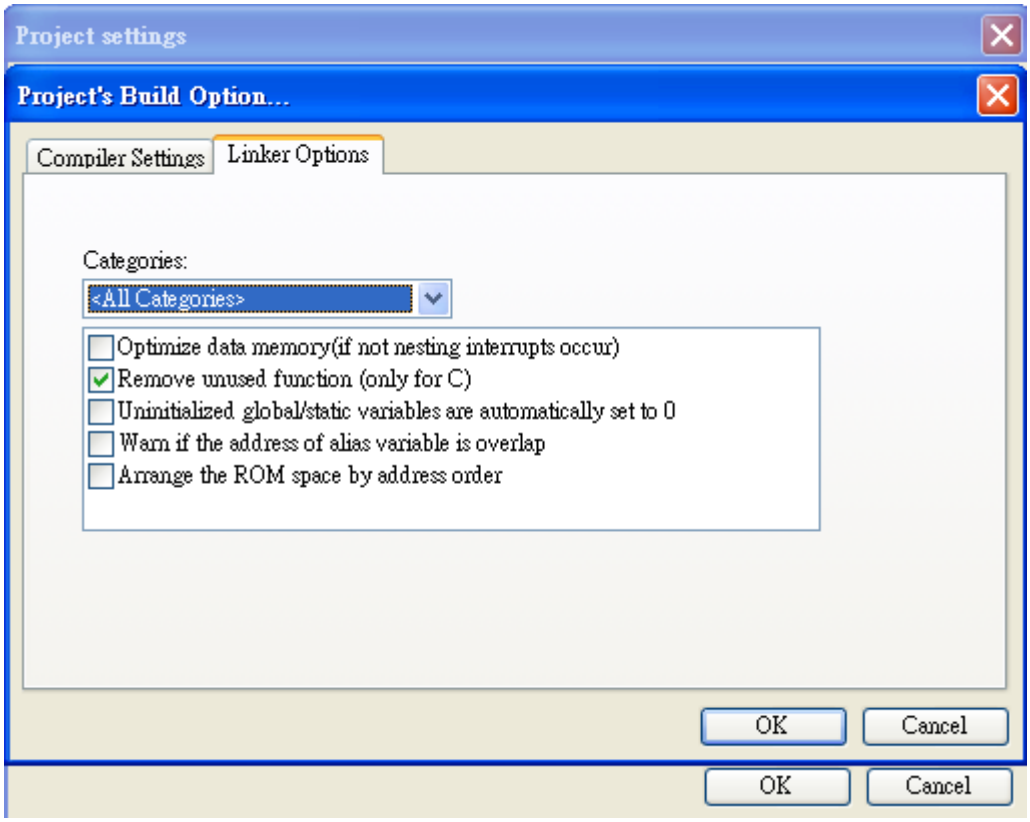



Fig 8-2

## Map File

The map file lists the names and loads the addresses and lengths of all sections in a program as well as listing the messages it encounters. The Cross Linker gives the address of the program entry point at the end of the map file. The map file also lists the names and loads addresses of all public symbols. The names and file names of the external symbols or procedures are recorded in the map file if no corresponding public symbol or procedure can be found. The contents of the map file are as follows :

Input Object File: C:\t\T.OBJ
Input Object File: C:\t\STARTUP1_L.OBJ

Input Library File: C:\Program Files\Holtek MCU Development Tools\HT-IDE3000V7.81\LIB\LIBHOLTEKGCC.LIB

```
Input Library File: C:\Program Files\Holtek MCU Development Tools\HT-IDE3000V7.81\LIB\v3_mrsc.lib
Input Library File: C:\Program Files\Holtek MCU Development Tools\HT-IDE3000V7.81\LIB\v3_tabrd_mrsc.lib

Bank  Start  End  Length  Class  Name
00h   0000h  0000h  0001h  CODE  @code (C:\t\T.OBJ)
00h   0001h  0001h  0001h  CODE  _main (C:\t\T.OBJ)
00h   0002h  0002h  0001h  CODE  @ROMDATA_BASE (C:\t\STARTUP1_L.OBJ)
00h   0004h  0007h  0004h  CODE  @isr04_code (C:\t\T.OBJ)
00h   0008h  0028h  0021h  CODE  @start (C:\t\T.OBJ)
00h   0029h  0033h  000bh  CODE  _isr04 (C:\t\T.OBJ)
00h   0034h  0038h  0005h  CODE  _fun (C:\t\T.OBJ)
00h   0080h  0081h  0002h  DATA  @HCCINIT0 (C:\t\T.OBJ)

Local Sections

Bank  Start  End  Length  Class  Name
00h   0085h  0085h  0000h  LOCAL  @dummy4 (C:\t\T.OBJ)
00h   0082h  0084h  0003h  LOCAL  _isr04 (C:\t\T.OBJ)
00h   0085h  0085h  0000h  LOCAL  @dummy (C:\t\T.OBJ)
00h   0085h  0085h  0000h  LOCAL  _main (C:\t\T.OBJ)
00h   0085h  0085h  0000h  LOCAL  _fun (C:\t\T.OBJ)

    Public Symbols Information
    Address  Public by Name
    0034h  _fun
    0080h  _g_a
    0029h  _isr04
    0082h  _isr04fs
    0001h  _main
    0001h  startup_value_1

    Address  Public by Value
    0001h  _main
    0001h  startup_value_1
    0029h  _isr04
    0034h  _fun
    0080h  _g_a
    0082h  _isr04fs

Error(L2001) : Unresolved external symbol '_g_b' in file 'C:\t\T.OBJ'

ROM Usage Statistics
    Size  Used  Percentage
    2000h  0038h  0%

RAM Usage Statistics
    Bank  Size  Used  Percentage
```

```
00h         0080h       0005h     3%
01h         0080h       0000h     0%
02h         0080h       0000h     0%
Total       0180h       0005h     1%

Use Stack Count
_isr04: 0
_main: 1

Call Tree
    @dummy4
        _isr04
    @dummy
        _main
            _fun

    Total 1 error(s), Total 0 Warning(s)
```

## Cross Linker Task File and Debug File

One of the Cross Linker's output files is the task file which consists of two parts, a task header and binary code. The task header contains the Cross Linker version, the MCU name and the ROM code size. The binary code part contains the program codes. The other Cross Linker output file is the debug file which contains all information referred to by the IDE debugging program. This information includes source file names, symbol names and line numbers as defined in the source files. The IDE will refer to the symbolic debugging function information. This file should not be deleted unless the debugging procedure is completed, otherwise the IDE will be unable to support the symbolic debugging function.

# Part III

# Utilities

In addition to the previously discussed general purpose 8-bit MCU development tools, the comapny also supplies several other utilities for its range of special purpose Voice and LCD MCU devices by supplying all the necessary tools and step by step guide for relevant simulation of voice synthesis and tone generator applications as well as the tools for real time hardware LCD panel simulation. This part contains all the information needed to program and debug relevant applications quickly and efficiently.

Chapter 9

# Library Manager

9

## What the Library Manager Does

The Library Manager provides functions to process the library files. The library files are utilized in the creation of the output file by the Cross Linker. Alibrary is a collection of one or more object modules which are assembled or compiled and ready for linking. It stores the modules that other programs may require for execution.

By using the Library Manager, library files can be created. Object files including common routines may be added to the library files. Before creating these object files, the names of all common routines must be made public by using the assembly directive PUBLIC (refer to the chapter on Assembly Language and Cross Assembler). The Cross Assembler generates the output object file (.OBJ) while the Library Manager adds this object file into the specified library file. When the Cross Linker has found unresolved names in a program during the linking process, it will search the library files for these unresolved names, and extracts a copy of the module containing that name. If an unresolved name has been found in this library module, the module will be linked to the program.

## To Setup the Library Files

The Library Manager provides the following functions :

- Create new library files
- Add/Delete a program module to/from a library file

- Extract a program module from a library file, and create an object file

To select use the Tools Menu and the Library Manager command as shown in Fig 9-1. Fig 9-2 shows the dialogue box for processing the functions of the Library Manager.

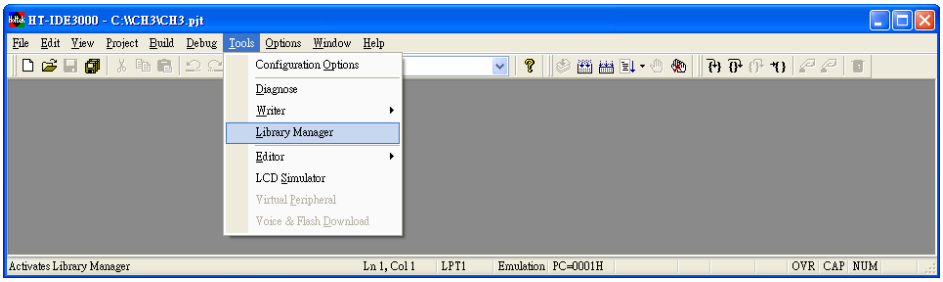



Fig 9-1

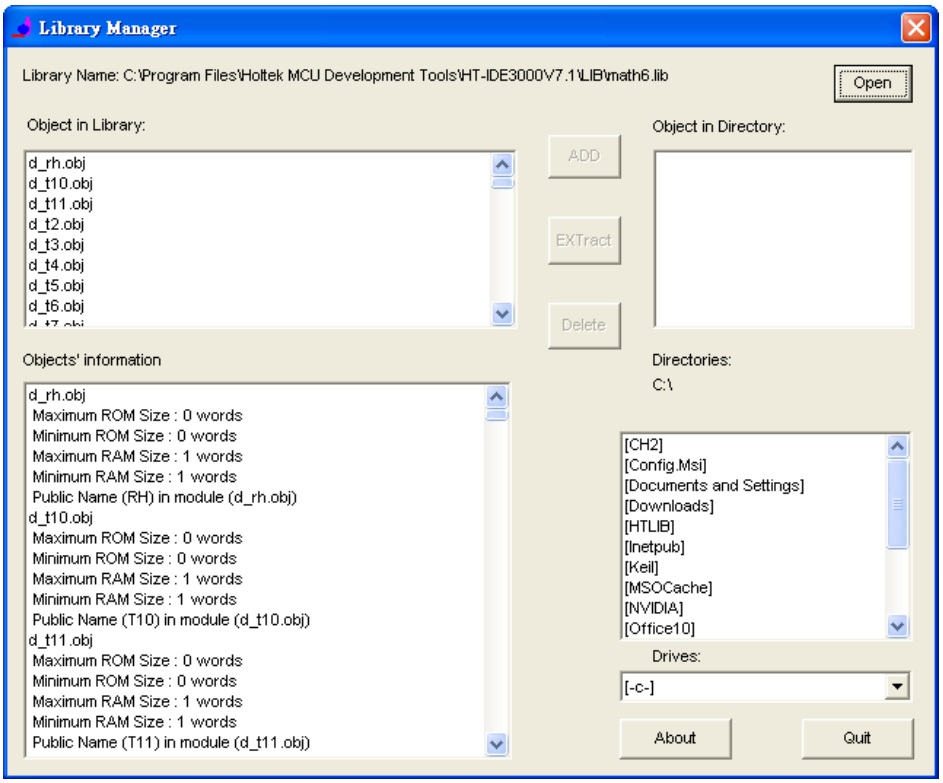



Fig 9-2

## Create a New Library File

Press Open button, Fig 9-3 is displayed

Type in a new library file name and press the OK button, Fig 9-4 is displayed for confirmation. If the Yes button is chosen, a new library file will be created but will not contain any program modules.

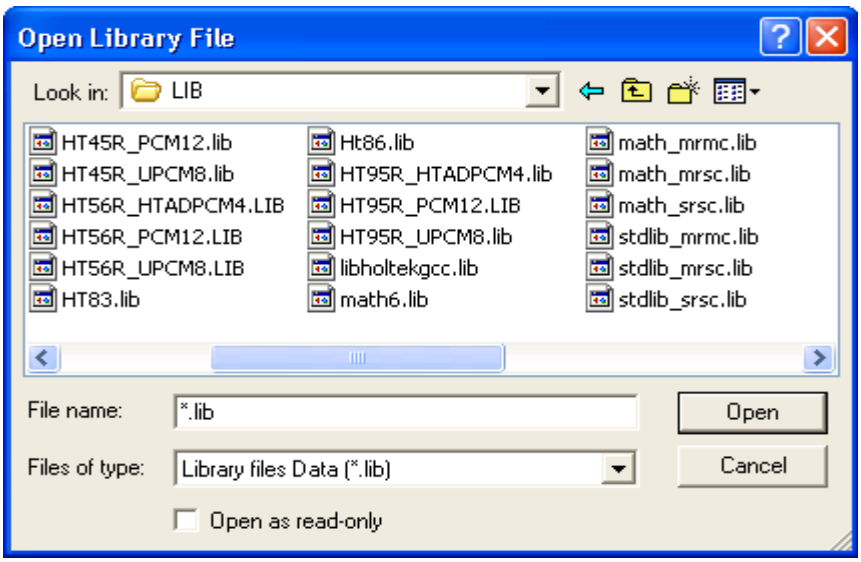



Fig 9-3

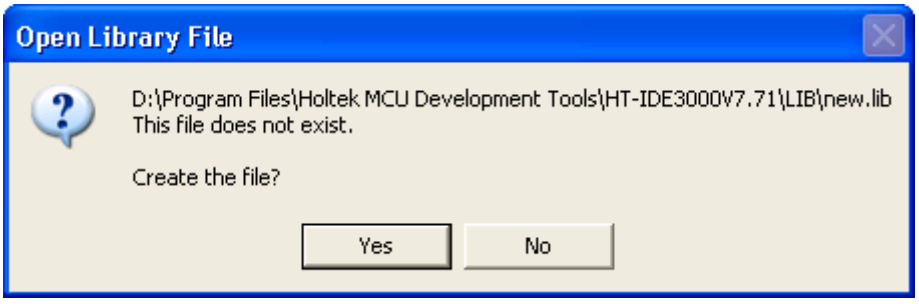



Fig 9-4

## Add a Program Module into a Library File

Select an object module from the “Object in Directory” box, and press the [ADD] button to add this object module into this library file.

## Delete a Program Module from a Library File

Select an object module from the “Object In Library” box, and press the [Delete] button to delete this object module from the library file.

## Extract a Program Module from Library and Create An Object File

Select an object module from the “Object in Library” box, and press [ExTract] button. A file will then be created with the same name and same content as the selected object module. It is displayed on the “Object in Directory” box.

## Object Module Information

Press the Open button, Fig 9-3 is displayed. Select a library file from the box below the File Name box, press OK button. From Fig 9-2, all the object modules of the selected library file are listed in the “Object in Library” box. The following information about each object module is also listed in the “Objects’ Information” box :

- Maximum ROM size

  The maximum size used by this object module program code. Dependent upon the code section align type.
- Minimum ROM size

  The minimum actual size used by this object module program code
- Maximum RAM size

  The maximum size used by this object module program data. It depends on the data section align type.
- Minimum RAM size

  The minimum, actual size used by this object module program data.
- Public Name

  The names of all public symbols in this object module.

P a r t I V

# Appendix

A p p e n d i x A

# Reserved Words

# Used By Cross Assembler

## Reserved Assembly Language Words

The following table lists all reserved words used by the assembly language.

- Reserved Names (directives, operators)

| | | | |
|---|---|---|---|
| $ | DUP | INCLUDE | NOT |
| * | | LABEL | OFFSET |
| + | ELSE | .LIST | OR |
| - | END | .LISTINCLUDE | ORG |
| . | ENDIF | .LISTMACRO | PAGE |
| / | ENDM | LOCAL | PARA |
| = | ENDP | LOW | PROC |
| ? | EQU | MACRO | PUBLIC |
| [ ] | ERRMESSAGE | MESSAGE | RAMBANK |

| | | | |
|---|---|---|---|
| AND | EXTERN | MID | ROMBANK |
| BANK | HIGH | MOD | .SECTION |
| BYTE | IF | NEAR | SHL |
| DB | IFDEF | .NOLIST | SHR |
| DBIT | IFE | .NOLISTINCLUDE | WORD |
| DC | IFNDEF | .NOLISTMACRO | XOR |

- Reserved Names (instruction mnemonics)

| | | | |
|---|---|---|---|
| ADC | HALT | RLCA | SUB |
| ADCM | INC | RR | SUBM |
| ADD | INCA | RRA | SWAP |
| ADDM | JMP | RRC | SWAPA |
| AND | MOV | RRCA | SZ |
| ANDM | NOP | SBC | SZA |
| CALL | OR | SBCM | TABRDC |
| CLR | ORM | SDZ | TABRDL |
| CPL | RET | SDZA | XOR |
| CPLA | RETI | SET | XORM |
| DAA | RL | SIZ | |
| DEC | RLA | SIZA | |
| DECA | RLC | SNZ | |

- Reserved Names ( registers names )

| | | | |
|---|---|---|---|
| A | WDT | WDT1 | WDT2 |

# Instruction Sets

**Arithmetic Instructions**

| | |
|---|---|
| ADD A,[m] | Add Data Memory to ACC |
| ADDM A,[m] | Add ACC to Data Memory |
| ADD A,x | Add immediate data to ACC |
| ADC A,[m] | Add Data Memory to ACC with carry |
| ADCM A,[m] | Add ACC to Data Memory with carry |
| SUB A,x | Subtract immediate data from ACC |
| SUB A,[m] | Subtract Data Memory from ACC |
| SUBM A,[m] | Subtract Data Memory from ACC with result in Data Memory |
| SBC A,[m] | Subtract Data Memory from ACC with carry |
| SBCM A,[m] | Subtract Data Memory from ACC with carry and result in Data Memory |
| DAA [m] | Decimal adjust ACC for addition with result in Data Memory |

**Logic Operation Instructions**

| | |
|---|---|
| AND A,[m] | AND Data Memory to ACC |
| OR A,[m] | OR Data Memory to ACC |
| XOR A,[m] | Exclusive-OR Data Memory to ACC |
| ANDM A,[m] | AND ACC to Data Memory |
| ORM A,[m] | OR ACC to Data Memory |
| XORM A,[m] | Exclusive-OR ACC to Data Memory |
| AND A,x | AND immediate data to ACC |
| OR A,x | OR immediate data to ACC |
| XOR A,x | Exclusive-OR immediate data to ACC |
| CPL [m] | Complement Data Memory |
| CPLA [m] | Complement Data Memory with result in ACC |

**Increment & Decrement Instructions**

| | |
|---|---|
| INCA [m] | Increment Data Memory with result in ACC |
| INC [m] | Increment Data Memory |
| DECA [m] | Decrement Data Memory with result in ACC |
| DEC [m] | Decrement Data Memory |

**Rotate Instructions**

| | |
|---|---|
| RRA [m] | Rotate Data Memory right with result in ACC |
| RR [m] | Rotate Data Memory right |
| RRCA [m] | Rotate Data Memory right through carry with result in ACC |
| RRC [m] | Rotate Data Memory right through carry |
| RLA [m] | Rotate Data Memory left with result in ACC |
| RL [m] | Rotate Data Memory left |
| RLCA [m] | Rotate Data Memory left through carry with result in ACC |
| RLC [m] | Rotate Data Memory left through carry |

**Data Move Instructions**

| | |
|---|---|
| MOV A,[m] | Move Data Memory to ACC |
| MOV [m],A | Move ACC to Data Memory |
| MOV A,x | Move immediate data to ACC |

**Bit Operation Instructions**

| | |
|---|---|
| CLR [m].i | Clear bit of Data Memory |
| SET [m].i | Set bit of Data Memory |

**Branch Instructions**

| | |
|---|---|
| JMP addr | Jump unconditionally |
| SZ [m] | Skip if Data Memory is zero |
| SZA [m] | Skip if Data Memory is zero with data movement to ACC |
| SZ [m].i | Skip if bit i of Data Memory is zero |
| SNZ [m].i | Skip if bit i of Data Memory is not zero |
| SIZ [m] | Skip if increment Data Memory is zero |
| SDZ [m] | Skip if decrement Data Memory is zero |
| SIZA [m] | Skip if increment Data Memory is zero with result in ACC |
| SDZA [m] | Skip if decrement Data Memory is zero with result in ACC |
| CALL addr | Subroutine call |
| RET | Return from subroutine |
| RET A,x | Return from subroutine and load immediate data to ACC |
| RETI | Return from interrupt |

**Table Read Instructions**

| | |
|---|---|
| TABRDC [m] | Read ROM code (current page) to Data Memory and TBLH |
| TABRDL [m] | Read ROM code (last page) to Data Memory and TBLH |

**Miscellaneous Instructions**

| | |
|---|---|
| NOP | No operation |
| CLR [m] | Clear Data Memory |
| SET [m] | Set Data Memory |
| CLR WDT | Clear Watchdog Timer |
| CLR WDT1 | Pre-clear Watchdog Timer |
| CLR WDT2 | Pre-clear Watchdog Timer |
| SWAP [m] | Swap nibbles of Data Memory |
| SWAPA [m] | Swap nibbles of Data Memory with result in ACC |
| HALT | Enter Power Down Mode |